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Facing Puberty: Exploring The Onset, Symptoms And Experience Of Menses In Females With Autism Spectrum Disorder

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Facing Puberty: Exploring The Onset, Symptoms And Experience Of Menses In Females With Autism Spectrum Disorder

Abstract
Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder resulting in language and social communication impairments, restricted interests, and repetitive behaviors. Previous research has focused on the cause, onset, and early years of the disorder, leaving the life course trajectory unknown. For females in particular, who comprise approximately 20% of individuals with ASD, a dearth of knowledge surrounding adolescence and puberty may pose challenges as the social, cognitive, and developmental growth inherent to puberty overlaps the social, developmental, and behavioral impairments of ASD. Few studies have addressed puberty in females with ASD and have reported mixed findings regarding its onset and presentation. In this study, puberty is represented by menses. The purpose of this mixed-methods study was to explore the onset, symptoms, and experience menses in females with ASD compared to Neurotypical peers through self- and parent-report on web-based questionnaires and semi-structured interviews with ASD parent-participant dyads. Analysis revealed a significant effect of ASD diagnosis in the participant or a sibling of the participant on age at menarche (AAM), with ASD females from multiplex families (families with two or more children diagnosed with ASD) reporting significantly earlier AAM (11.01 ± 1.10 years) than Neurotypical females with no family history of ASD (12.86 ± 0.94 years; p < 0.05). Females with ASD were less likely to report pre-menstrual symptoms than Neurotypical females, yet reported dysmenorrheal, physical, behavioral, and emotional menstrual symptoms at similar rates. Females with ASD who reported menstrual symptoms indicated experiencing greater burden of behavioral and emotional symptoms than Neurotypical females. Parents were accurate reporters of their daughters’ AAM, but not menstrual symptom presentation. Interviews with ASD parent-participant dyads revealed six themes: preparations for puberty, the physical experience of menses, speed bumps on the road through puberty, managing the everyday, looking to the future, and reflective advice. Together, these findings highlight the complex presentation of puberty in females with ASD, underscoring the need for disorder-specific education, healthcare, and interventions that promote the well-being of young women throughout adolescence and adulthood.

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Jennifer Pinto-Martin

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FACING PUBERTY: EXPLORING THE ONSET, SYMPTOMS AND EXPERIENCE OF MENSES IN FEMALES WITH AUTISM SPECTRUM DISORDER

Whitney Eriksen

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in

Nursing

Presented to the Faculties of the University of Pennsylvania

in

Partial Fulfillment of the Requirements for the

Degree of Doctor of Philosophy

2016

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My mother, Pamela Jeanne Starzinger, who opened my eyes to the joys of working with those with Special Needs,

And Christopher Logan Harley, my rock.
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To the mothers, fathers, and daughters who participated in The Facing Puberty Study, you have my deepest gratitude and thanks. None of this was possible without you. Your stories continue to move and motivate me every day.
ABSTRACT

FACING PUBERTY: EXPLORING THE ONSET, SYMPTOMS AND EXPERIENCE OF MENSES IN FEMALES WITH AUTISM SPECTRUM DISORDER

Whitney Eriksen
Jennifer Pinto-Martin

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder resulting in language and social communication impairments, restricted interests, and repetitive behaviors. Previous research has focused on the cause, onset, and early years of the disorder, leaving the life course trajectory unknown. For females in particular, who comprise approximately 20% of individuals with ASD, a dearth of knowledge surrounding adolescence and puberty may pose challenges as the social, cognitive, and developmental growth inherent to puberty overlaps the social, developmental, and behavioral impairments of ASD. Few studies have addressed puberty in females with ASD and have reported mixed findings regarding its onset and presentation. In this study, puberty is represented by menses. The purpose of this mixed-methods study was to explore the onset, symptoms, and experience menses in females with ASD compared to Neurotypical peers through self- and parent-report on web-based questionnaires and semi-structured interviews with ASD parent-participant dyads. Analysis revealed a significant effect of ASD diagnosis in the participant or a sibling of the participant on age at menarche (AAM), with ASD females from multiplex families (families with two or more children diagnosed with ASD) reporting significantly earlier AAM (11.01 ± 1.10 years) than Neurotypical females with no family history of ASD (12.86 ± 0.94 years; p <
0.05). Females with ASD were less likely to report pre-menstrual symptoms than Neurotypical females, yet reported dysmenorrheal, physical, behavioral, and emotional menstrual symptoms at similar rates. Females with ASD who reported menstrual symptoms indicated experiencing greater burden of behavioral and emotional symptoms than Neurotypical females. Parents were accurate reporters of their daughters’ AAM, but not menstrual symptom presentation. Interviews with ASD parent-participant dyads revealed six themes: preparations for puberty, the physical experience of menses, speed bumps on the road through puberty, managing the everyday, looking to the future, and reflective advice. Together, these findings highlight the complex presentation of puberty in females with ASD, underscoring the need for disorder-specific education, healthcare, and interventions that promote the well-being of young women throughout adolescence and adulthood.
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Introduction
Overview of the Study

Autism Spectrum Disorder (ASD), a neurodevelopmental disorder characterized by (1) impairments in social interaction and communication, and (2) restricted, repetitive patterns of behavior or interests, has seen a dramatic rise in prevalence in the United States over the past 25 years, with a near three fold increase from 2000 to 2010 alone (1:166 in 2000 to 1:68 in 2010; American Psychiatric Association, 2013; Christensen, 2016). Whether resulting from improved diagnostic tools and practices (Guevara et al., 2013; King & Bearman, 2009), increased awareness, or an increase in the rates of developmental disorders (Isaksen, Diseth, Schjolberg, & Skjeldal, 2013), ASD has become commonplace in the United States (Baxter et al., 2014; Bhat, Acharya, Adeli, Bairy, & Adeli, 2014; Buescher, Cidav, Knapp, & Mandell, 2014). As of 2016, ASD is believed to impact the lives of one in 42 males and one in 189 females in the United States (Christensen, 2016), making this developmental disorder more common than all childhood cancers combined (Siegel et al., 2014). Despite the dramatic increase in prevalence, the significant costs associated with care for individuals with ASD across the lifespan (Buescher et al., 2014; Lavelle et al., 2014; Peacock, Amendah, Ouyang, & Grosse, 2012), and the impact of a diagnosis of ASD on quality of life, safety and mortality (Billstedt, Gillberg, & Gillberg, 2005; Brenner et al., 2013; Jain et al., 2014; L. C. Lee, Harrington, Chang, & Connors, 2008), research on ASD remains focused primarily on young children and on unveiling the cause or causes of ASD (Interagency Autism Coordinating Committee (IACC), 2014; Perkins & Berkman, 2012). While a laudable goal, it does not directly address the scores of individuals living beyond the age
of diagnosis with ASD into adolescence and adulthood, and the realities and difficulties of life they face on a daily basis. Similarly, research to date has typically drawn on white males as participants (Krahn & Fenton, 2012), overlooking the experiences of ASD for those falling outside of this group. Females with ASD in particular have been largely ignored from research (Kirkovski, Enticott, & Fitzgerald, 2013; Lai et al., 2013; Shefcyk, 2015; Werling & Geschwind, 2013), leaving their trajectory across the lifespan a relative mystery (Cridland, Jones, Caputi, & Magee, 2014; Halladay et al., 2015; Shefcyk, 2015).

Puberty marks the transition from childhood to adulthood. Physically, the body develops into its adult frame and function; cognitively, the mind gains skills in abstract thinking and executive control; and socially, the individual’s relationships shift towards friendships and romantic relationships. For children with ASD puberty poses unique challenges: the social, cognitive and developmental growth inherent to puberty overlays the social, developmental and behavioral impairments of ASD, resulting in an experience that may be as singular and challenging as the diagnosis of ASD itself. Females with ASD face additional difficulties with the onset of menses, or menstrual cycle, requiring access to safe and accurate age-, gender-, and disorder-specific education and healthcare. Currently, few studies have addressed issues surrounding puberty in this growing population (Burke, Kalpakjian, Smith, & Quint, 2010; Hamilton, Marshal, & Murray, 2011; Hergüner & Hergüner, 2016; Ingudomnukul, Baron-Cohen, Wheelwright, & Knickmeyer, 2007; Knickmeyer, Wheelwright, Hoekstra, & Baron-Cohen, 2006; Pohl, Cassidy, Auyeung, & Baron-Cohen, 2014; Whitehouse, Maybery, Hickey, & Sloboda, 2011). Those that have addressed this transition suggest that females with ASD
experience menarche, the first menstrual period, at times incongruent to their peers (Burke et al., 2010; Hamilton et al., 2011; Knickmeyer et al., 2006; Whitehouse et al., 2011), demonstrate elevated rates of both precocious puberty and primary amenorrhea (Burke et al., 2010; Ingudomnukul et al., 2007; Knickmeyer et al., 2006; Pohl et al., 2014), and experience significantly more symptoms surrounding menses (Burke et al., 2010; Ingudomnukul et al., 2007; D. O. Lee, 2004; Pohl et al., 2014). Additionally, several studies have observed elevated rates of disorders related to menstruation, such as polycystic ovarian syndrome, in females with ASD and mothers of children with ASD (Ingudomnukul et al., 2007; Pohl et al., 2014).

Puberty isn’t a singular event; it is a daily experience, a steady series of steps towards adulthood. As all who have gone through this transition period know, it is a process of getting re-acquainted with one’s developing body and ever changing hormones, navigating a dynamic and challenging social environment, developing new cognitive skills, and being in many ways simultaneously a child and an adult. While this natural life event may pose its challenges in the most well adjusted Neurotypical child, those with a diagnosis of ASD may experience additional and significant behavioral, physical and mental health issues that are currently not known nor well understood.

**Significance**

This study has sought to build on previous research regarding the onset and symptoms of menses in females with ASD, to inform the individuals, as well as their families and parents, about the possible course or courses this aspect of puberty may take. Understanding the onset, typical presentation and problems surrounding puberty for this
growing population is critical for their current and future health. For females, menses is a central tenant of puberty, denoting reproductive capacity and marking the beginning of womanhood in many cultures (Beausang & Razor, 2000; Rembeck, Möller, & Gunnarsson, 2006). Age at menarche is a known predictor of significant health concerns, such as breast cancer (Collaborative Group on Hormonal Factors in Breast Cancer, 2012; Petridou et al., 1996; Stoll, Vatten, & Kvinnsland, 1994), and depression (Joinson, Heron, Lewis, Croudace, & Araya, 2011; Kaltiala-Heino, Kosunen, & Rimpela, 2003; Stice, Presnell, & Bearman, 2001), while atypical or severe menstrual symptoms have been linked to conditions ranging from anemia (Bevan et al., 2001) to polycystic ovarian syndrome (da Silva Bouzas, Cader, Leao, Kuschnir, & Braga, 2014). Though menses may present a challenge in its’ own right, it may be complicated by the symptoms of ASD: mastering the management of menses may be difficult due to the individual’s emotional and behavioral challenges and the severity of ASD; menstrual symptoms may interact with symptoms of ASD to exacerbate either or both. Additionally, menses may bring increased anxiety, resistance to changes in the body, and difficulties in finding appropriate and acceptable hygiene products.

This study has further sought to identify areas for future research surrounding puberty in females with ASD. Understanding the manifestation of menses in this population is key to promoting a smooth transition through adolescence, setting the stage for developing healthy body image, and promoting mental and physical health through this phase of life and beyond. The results of this study have implications in the development of appropriate and timely education, healthcare, and supports for females.
with ASD, their families and practitioners that serve them. Further, the results of this study have implications for the health of females with ASD by identifying gynecologic risk factors, notably early menarche, that are known to be associated with health conditions across the lifespan.

**Specific Aims**

The goal of this explanatory sequential mixed method study (QUAN + qual) was to explore the onset and symptom presentation of puberty, represented by menses, in females with ASD compared to their Neurotypical (NT) peers, and to understand the impact of menses on females and their families in years following menarche. The complex interface of these two phenomena (ASD and menses) required a similarly multifaceted approach: the explanatory sequential design was ideal as it allowed purposeful exploration to reach a deep and thorough understanding of the phenomena that would be impossible through a single approach alone. This study consisted of two phases: Phase 1: Quantitative, combined self- and parent-report on web-based questionnaires to assess onset and presentation of menstrual symptoms and factors known to influence menarche and menses (e.g., exercise, BMI, race/ethnicity) from a sample of ASD and NT populations in the United States; and Phase 2: Qualitative, employed semi-structured interviews with parent-participant dyads selected through purposive sampling using data collected in Phase 1 to achieve a heterogeneous group for age, age at menarche, ASD diagnosis, and race/ethnicity. This study is the first to simultaneously address the presentation, experience and meaning of menses for females with ASD compared to their NT peers.
Specific Aims:

1. Describe the onset and symptoms of menses in females with ASD compared to Neurotypical peers, with specific attention to: (1) age at menarche, (2) length and regularity of cycle, and (3) number and severity of menstrual symptoms, while controlling for factors known to associated with menarche and menses.

2. Characterize the differences between self-report and parental-report of age at menarche and menstrual symptoms for females with ASD and Neurotypical peers.

3. Explore the experience of menses for females with ASD and their families through semi-structured interviews.

Background

Autism Spectrum Disorders

It has been well established that individuals with ASD exhibit significant variety in the hallmark symptoms of the disorder (American Psychiatric Association, 2013). Mirroring the heterogeneity of symptoms, the community itself encompasses both males and females of all ages, from all racial, ethical and socio-economic groups and countries across the globe (Christensen, 2016). The cause of ASD is thought to be a combination of genetic and environmental factors, impacting brain development in utero (Bhat et al., 2014), and there is currently no known cure for the disorder. As an inherently pervasive, lifelong disorder, individuals with ASD experience the core symptoms throughout their lives, though many show improvement with targeted intervention (Bhat et al., 2014). Despite the current trends of research on ASD focusing primarily on identifying causes of the disorder, improving diagnostic tools to decrease age at diagnosis, expression of
symptoms in early life, and pharmacologic and non-pharmacologic treatments of the disorder (Daniels, 2012; Interagency Autism Coordinating Committee (IACC), 2014), there is a growing body of knowledge focusing on the life course trajectory of those with ASD (Billstedt et al., 2005; Gray et al., 2014; Perkins & Berkman, 2012; Seltzer et al., 2003).

As children with ASD age, challenges posed by their diagnosis are supplemented with the common challenges of growing up (Fong, Wilgosh, & Sobsey, 1993; Seltzer et al., 2003). Community resources, such as the ‘Tool Kits’ offered through Autism Speaks, a non-profit advocacy organization for ASD, present information and guidance for families of children on spectrum insofar as information is available. However, for adolescents and adults this is truly lacking. In the Transition Tool Kit offered through Autism Speaks, Peter Gerhardt notes that “little is known about the interaction of ASD and aging […]. Concerns related to the long term health and wellness of adults with ASD should be at the forefront of any discussion of appropriate services” (Autism Speaks, 2011). In practice however, issues surrounding physical maturation and sexuality in adolescence and adulthood often take second place to mental health concerns presented by ASD.

Due to the multifaceted effects of puberty, impacting both physical and mental health, it is an area of potential concern for the ASD population. Literature to date suggests that the majority of individuals with ASD experience steady improvements in the core symptoms of ASD with targeted intervention, though impairments do persist into adulthood. A recent review of the literature on life-course trajectory of ASD symptoms
and impairments associated with the disorder observed significant variability in published findings across and within studies (Magiati, Tay, & Howlin, 2014). For the majority of individuals with ASD, cognitive functioning and intellectual ability remain stable over time (Magiati et al., 2014), with a minority of individuals showing significant decreases beginning at puberty (Howlin, Savage, Moss, Tempier, & Rutter, 2014; Sigman & McGovern, 2005). Similarly, language and communication skills generally improve as the individual ages, though levels remained below their NT peers and poor functional language skills were reported in adolescence and adulthood (Magiati et al., 2014; Seltzer et al., 2003). Behavioral symptoms, such as restricted interests, repetitive behaviors, and resistance to change, decreased as individuals aged, though individuals with severe Autism or Intellectual Disability (ID) showed fewer improvements, and occasionally saw increases in these behaviors (Magiati et al., 2014; Seltzer et al., 2003). Especially salient to this study, the onset of co-morbid disorders and psychiatric conditions at puberty in individuals with ASD, such as anxiety, depression and epilepsy, has been well documented (Davis III et al., 2011; Gillberg, 1984; Gillberg & Steffenburg, 1987; Magiati et al., 2014). Concerns voiced by parents and clinicians were diverse and encompass behavioral (aggression, tantrums), social and communicative (inappropriate or inadequate social skills), educational (choosing integrated versus specialized services) and concerns about independence (residential, vocational; Seltzer et al., 2003). Puberty and adolescence, while presenting an opportunity for growth and improvement, also represent a high-risk period for these individuals (Gillberg, 1984; Seltzer et al., 2003).

Puberty and Menses in Neurotypical Females
Puberty, rather than a single life event, is the process of reaching physical and reproductive maturity. In females, the process begins with activation of the hypothalamic-pituitary-gonadal (HPG) axis, triggering a cascade of hormones that result in maturation of the reproductive system (gonadarche) and emergence of secondary sexual characteristics, including breast development (thelarche), axillary and pubic hair growth (pubarche), and finally onset of the menstrual cycle (menarche). While menarche itself is a rather late marker of puberty, occurring two to three years after thelarche (Cabrera, Bright, Frane, Blethen, & Lee, 2014; Y. Lee & Styne, 2013), it is frequently used as a proxy for pubertal timing due to issues in determining a “true” and clear onset of puberty and the challenges in accurately reporting thelarche (Coleman & Coleman, 2002). Menarche is a distinct event, more easily observed and is noted for accuracy in self-report, even up to 30 years later (Cooper et al., 2006; Koo & Rohan, 1997; Must et al., 2002). There has been a well-documented decrease in age at menarche over the past 300 years in Western Cultures (Adams Hillard, 2008; Wyshak & Frisch, 1982), from 17-18 years in the 18th century (Y. Lee & Styne, 2013) to 12 to 13 years in the 20th century (Cabrera et al., 2014; Chumlea et al., 2003). The decreasing trend in AAM from the 18th to the 21st century is believed to be the result of improved nutrition, health and socio-economic status, and is associated with these variables (Lehmann, Scheffler, & Hermanussen, 2010). In the United States, the mean AAM for non-Hispanic White females is 12.77 years, compared to 12.17 years for non-Hispanic Black females (Cabrera, Bright, Frane, Blethen & Lee, 2014). AAM has been associated with a number of variables, such as mother’s AAM, body mass index (BMI), genetic factors, race and
ethnicity, stress, physical activity and nutrition (Adams Hillard, 2008; Berkey, Gardner, Frazier, & Colditz, 2000; Braithwaite et al., 2009; Davis III et al., 2011; Karapanou & Papadimitriou, 2010).

Many terms have been used in the literature to describe variation in the age at menarche, including early menarche, late menarche, delayed puberty, precocious puberty and primary amenorrhea. While some of these terms overlap, some have clinically distinct meanings that are critical to understanding the phenomenon of menses. Early menarches and early puberty, for example, have been used interchangeably with definitions suggesting age at onset ranging anywhere from 9 to 12 years. Here the term early menarche is used and is defined as AAM equal to or less than 11 years. Similarly, late menarche and late puberty are often used in similar context; late menarche is favored here, defined as AAM equal to or greater than 14 years of age. Precocious puberty in females is clinically defined as the onset of breast and pubic hair development prior to eight years of age. Central precocious puberty occurs when the hypothalamus is prematurely activated to release gonadotropin-releasing hormone; other causes include tumors of the ovary or genetic conditions, such as McCune-Albright syndrome (Ball, Bindler, & Cowen, 2011). Primary amenorrhea, the absence of menarche and development of secondary sexual characteristics by 14 years of age or absence of menarche by 16 years of age in the presence of development of secondary sex characteristics, may be caused by structural abnormalities in the reproductive system, chromosomal and genetic abnormalities, polycystic ovarian syndrome, or may have no
underlying pathology (Ball et al., 2011). Please refer to Table 1 for a detailed list of variables associated with early and late menarche.

**Table 1. Risk Factors for Early and Late Menarche**

<table>
<thead>
<tr>
<th><strong>Early Menarche</strong></th>
<th><strong>Late Menarche</strong></th>
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<tr>
<td>Early AAM in mother</td>
<td>Heavy maternal tobacco use (&gt;20</td>
</tr>
<tr>
<td>Extreme maternal weight gain (&lt;10;&gt;40 lbg.)</td>
<td>cigarettes/day) during pregnancy)</td>
</tr>
<tr>
<td>Maternal preeclampsia</td>
<td>Nutritional deficiency</td>
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<tr>
<td>Large waist circumference</td>
<td>Low BMI</td>
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<tr>
<td>Exposure to low levels of lead</td>
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<tr>
<td>Adverse events in childhood</td>
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<tr>
<td>Maternal tobacco use during pregnancy</td>
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<tr>
<td>Small size at birth (SMGA, IUGR)</td>
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<tr>
<td>Increased BMI through childhood</td>
<td></td>
</tr>
<tr>
<td>Bottle feeding during infancy</td>
<td></td>
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<tr>
<td>Absent father in early childhood (&gt;5 years)</td>
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Age at menarche has been shown to be significantly associated with many health concerns across the lifespan. Early menarche is associated with increased BMI, insulin resistance and glucose intolerance (Feng et al., 2008; Remsberg et al., 2005), as well as increased risk of cardiovascular disease, coronary heart disease, all-cause mortality and cancer mortality (Lakshman et al., 2009; Petridou et al., 1996). Early age at menarche is further associated with adolescent depression and social anxiety (Blumenthal, Leen-Feldner, Trainor, Babson, & Bunaciu, 2009; Kaltiala-Heino et al., 2003). Late menarche is associated with increased risk of osteoporosis and bone fracture, possibly due to decreases in lifetime exposure to estrogen, particularly during peak bone acquisition periods (Chevalley, Bonjour, Ferrari, & Rizzoli, 2009; Ho & Kung, 2005). In cases of precocious puberty and primary amenorrhea, an underlying etiology should be sought and consideration given to interventions due to the effects of low estrogen on bone and
cardiac health (Chevalley et al., 2009; Feng et al., 2008; Gerdhem & Obrant, 2004; Grover, 2011; Ho & Kung, 2005; Remsberg et al., 2005). Table 2 details the health implications of which early and late menarche constitute risk factors.

Table 2. Health and Behavioral Implications of Early and Late Menarche.

<table>
<thead>
<tr>
<th>Early Menarche</th>
<th>Late Menarche</th>
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<tr>
<td>Increased BMI and abdominal type obesity</td>
<td>Osteoporosis</td>
</tr>
<tr>
<td>Increased cardiovascular risk and coronary heart disease</td>
<td>Increased risk of fractures</td>
</tr>
<tr>
<td>Increased risk for breast cancer</td>
<td></td>
</tr>
<tr>
<td>Early sexual debut, increased risk of STI</td>
<td></td>
</tr>
<tr>
<td>Increased risk for internalizing and externalizing problems, disruptive behavior disorders</td>
<td></td>
</tr>
<tr>
<td>Increased risk of eating disorders, social anxiety</td>
<td></td>
</tr>
<tr>
<td>Insulin resistance and glucose intolerance</td>
<td></td>
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<tr>
<td>Fertility impairment</td>
<td></td>
</tr>
<tr>
<td>Increased all-cause and cancer mortality</td>
<td></td>
</tr>
<tr>
<td>Increased risk for substance abuse and dependence</td>
<td></td>
</tr>
<tr>
<td>Increased risk for adolescent depression</td>
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</table>

In the year following menarche, the menstrual cycle becomes more regular, occurring at intervals of 20-45 days, with most cycles becoming ovulatory by the end of the first menstrual year (Hickey & Balen, 2003). By the end of the third menstrual year, 60-80% of females have cycles that mirror adult patterns, with cycle length lasting 21-34 days and period length between 3 and 7 days (Deligeoroglou & Tsimaris, 2010; Flug, Largo, & Prader, 1984; Hickey & Balen, 2003). When menarche occurs before 12 years of age, nearly all menstrual cycles are ovulatory by the fifth menstrual year; however, in females with later onset, all cycles may not be ovulatory for eight to twelve years (Hickey & Balen, 2003; Vihko & Apter, 1984). An individual’s cycle length and menstrual symptoms are typically established by the sixth menstrual year (Deligeoroglou & Tsimaris, 2010).
Menstrual symptoms are those associated with the hormonal fluctuation of the HPG axis in relation to the menstrual cycle; they may be physical, behavioral, or emotional, and vary in onset or severity across the cycle and menstrual years. Depending on the timing, grouping and severity of symptoms, they may be classified as a menstrual disorder, which include: dysmenorrhea, pelvic pain occurring with the onset of menstrual flow and lasting 2-3 days; premenstrual syndrome (PMS; A.D.A.M Medical Encyclopedia, 2012), physical, behavioral and emotion symptoms occurring during the luteal phase and decreasing following onset of menses; and premenstrual dysphoric disorder (PMDD; American Psychiatric Association, 2013), the most severe form of PMS with greater intensity and duration of symptoms, such that they significantly interfere with the individuals functional ability. Table 3 provides a list of physical, behavioral, and emotional symptoms associated with the menstrual cycle.

**Table 3. Symptoms of the Menstrual Cycle**

<table>
<thead>
<tr>
<th>Physical</th>
<th>Behavioral</th>
<th>Emotional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acne</td>
<td>Changes in sleep patterns</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Breast tenderness or pain</td>
<td>Changes in appetite</td>
<td>Changes in mood or mood swings</td>
</tr>
<tr>
<td>Bloating</td>
<td>Decreased interest</td>
<td>Depression</td>
</tr>
<tr>
<td>Cramps</td>
<td>Difficulties concentrating</td>
<td>Irritability or anger</td>
</tr>
<tr>
<td>Constipation</td>
<td>Social withdrawal</td>
<td>Tearfulness</td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headache</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dysmenorrhea occurs in 20-90% of women of reproductive age (Davis & Westhoff, 2001). While not as prevalent as dysmenorrhea, PMS and PMDD also occur in a significant portion of females in the United States, with PMS occurring in 20-40% (Clayton, 2008; Tschudin, Bertea, & Zemp, 2010) and PMDD in 2-9% of females (Clayton, 2008; Tschudin et al., 2010). Menstrual symptoms and disorders have significant impacts on a woman’s physical, mental and emotional health. PMS and PMDD are not exacerbations of other psychiatric illnesses, such as anxiety, depression or personality disorder, though those who do have these pathologies may experience cyclical changes in related symptoms (Clayton, 2008). Menstrual symptoms have been shown to significantly decrease quality of life, functional ability, and impair participation in activities of daily life, and are associated with increased utilization of health care resources, decreased productivity, and lost work days (Clayton, 2008). Dysmenorrhea is the most common cause of activity restriction and school or work absence in adolescents and young adults. Among women in the United States, 30% report menstrual symptoms interfering with their home life, 17% with social life, and 14% reported interference with work (Hylan, Sundell, & Judge, 1999). Further, women who report menstrual symptoms are 2.5 times more likely to report feelings of depression and anxiety, 2.4 times more likely to report insomnia, three times more likely to show excessive sleepiness, and 2.5 times more likely to report recurring pain in the previous 12 months (Strine, Chapman, & Ahluwalia, 2005). In adolescents, menstrual problems can lead to impaired physical and psychosocial functioning (Nur Azurah, Sanci, Moore, & Grover, 2013).
Menorrhagia, heavy menstrual periods equating to the loss of 80 mL or more of blood per period or four or more fully soaked pads per day at any point of the menstrual flow, is a common condition of menses and presents in approximately 30% of women (O'Flynn & Britten, 2000). While menorrhagia may be due to an underlying pathology, such as clotting disorder like von Willebrand’s, half of women who complain of menorrhagia have idiopathic etiology. Aside from risks of iron deficiency anemia related to blood loss (Peuranpaa, Heliovaara-Peippo, Fraser, Paavonen, & Hurskainen, 2014), women who complain of menorrhagia also report impaired quality of life during menses (Gokyildiz, Aslan, Beji, & Mecdi, 2013; Karlsson, Marions, & Edlund, 2014), specifically related to limitations in physical activities and social and leisure activities (Lukes, Baker, Eder, & Adomako, 2012).

Puberty and Menses in Females with a Neurodevelopmental Disability

Individuals with developmental disabilities have demonstrated differences regarding the onset of puberty; those with neurodevelopmental disorders, such as Cerebral Palsy, Down’s Syndrome, or Spina Bifida, are up to 20 times more likely to demonstrate early pubertal development (Siddiqi, Van Dyke, Donohoue, & McBrien, 1999). While precocious puberty occurs in approximately one in 10,000 Neurotypical females, the rates increase dramatically in the Spina Bifida population, nearly one in five females (Elias & Sadeghi-Nejad, 1994). Conversely, individuals with Cerebral Palsy experience menarche significantly later than Neurotypical peers (Worley et al., 2002). In females with ASD, the reported mean age at menarche has ranged from 11.7 to 13.8 years of age, and is inconsistently reported as different from Neurotypical peers and peers with
other developmental disabilities (Burke et al., 2010; Hamilton et al., 2011; Ingudomnukul et al., 2007; Knickmeyer et al., 2006; Pohl et al., 2014; Whitehouse et al., 2011). Cases of primary amenorrhea have been noted in the population (Ingudomnukul et al., 2007; Knickmeyer et al., 2006; Pohl et al., 2014), with one study finding significantly elevated rate of late menarche in females with ASD (7.4%; compared to 0.5% in the Neurotypical population; Ingudomnukul et al., 2007). Instances of precocious puberty have also been observed (Burke et al., 2010; Ingudomnukul et al., 2007; Pohl et al., 2014), with rates as high as 3.1% in females with ASD, compared to 0.5% in the NT population (Pohl et al., 2014). Interestingly, none have yet to detail the trajectory or clinical treatment of these individuals.

Symptoms surrounding menstruation appear to be experienced at higher rates in females with ASD compared to NT peers. Females with ASD have been reported as experiencing irregular cycles, dysmenorrhea, heavy flow and menorrhagia, severe acne, mood and behavioral changes, and hirsutism at greater rates than those without a developmental disorder (Burke et al., 2010; Ingudomnukul et al., 2007; Pohl et al., 2014). Mothers of females with ASD have shared that menses can be difficult for their daughters to manage: irregular cycles complicate management of menses, such as carrying or changing hygiene products; an unexpected cycle leads to increased behavioral problems; and painful periods interfere with the ability to participate in or perform daily activities, such as school or therapy. While menses undoubtedly interferes with daily activities in Neurotypical females, the added challenges accompanying a diagnosis of ASD may leave these individuals and families unable or ill equipped to cope. While the symptoms of
menses are beginning to be documented, the effects of menses on daily life and functioning with ASD are, to this point, poorly described and understood.

Table 4. Review of Published Literature on Menses in Females with ASD

* indicates significant finding, light grey square indicates variable not reported by study

<table>
<thead>
<tr>
<th>Article</th>
<th>N</th>
<th>AAM</th>
<th>EOP or PP</th>
<th>DP or PA</th>
<th>Menstrual Symptoms</th>
<th>Pre-menstrual Symptoms</th>
<th>PCOS</th>
<th>Hirsutism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knickmeyer et al 2006</td>
<td>ASD: 38 Controls: 38</td>
<td>ASD: 13.3 Controls: 12.58</td>
<td>PA: 3*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EOP = Early Onset Puberty; PP = Precocious Puberty; DP = Delayed Puberty; PA = Primary Amenorrhea; PCOS = Polycystic ovarian syndrome; DS = Down’s Syndrome; CP = Cerebral Palsy; HT = High Autism-like traits; TT = Typical Autism-like traits; LT = Low Autism-like traits

The overall gynecologic health of females with disabilities, notably developmental disabilities, is grossly understudied and reports that these women do not receive regular gynecologic care are not uncommon (Burke et al., 2010; Shah, Norlin, Logsdon, & Samson-Fang, 2005). The literature to date cannot distinctly state whether females with ASD experience menarche and menstruation differently than Neurotypical peers. Even without conclusive evidence, caregivers and providers of females with ASD
should recognize the importance of understanding the needs of females with ASD in relation to puberty.

**Gaps in the Literature**

Despite puberty being an area of significant growth and change, relatively little is currently known about the trajectory for females with ASD through adolescence. Studies have suggested that females with ASD may begin puberty, as represented by menarche, earlier or later than their Neurotypical peers and may experience significantly more menstrual symptoms. To date, few studies have considered factors known to be associated with age at menarche or menstrual symptoms, addressed access to and use of interventions for treating significant menstrual symptoms, spoken on the interaction between menstrual symptoms and symptoms of ASD, or given voice to these individuals themselves to understand the experience of puberty as a female with ASD (Burke et al., 2010; Ingudomnukul et al., 2007; Knickmeyer et al., 2006; Pohl et al., 2014; Whitehouse et al., 2011). This study sought to remediate those gaps.

**Conceptual Underpinnings**

As a mixed methods study, this research combines two distinct philosophies to investigate the phenomenon of puberty in females with ASD: a post-positivist stance in the Quantitative Phase, and a constructivist stance in the Qualitative Phase. While these two philosophies may initially appear at odds with each other, previous research has demonstrated the applicability and utility of joining top-down and bottom-up approaches to achieve a rich, deep understanding of the phenomenon of interest. Consistent with the
explanatory sequential design, the data from each phase was analyzed separately and mixed at the level of the conclusion.

**Table 5.** Conceptual Underpinnings for the Facing Puberty Study

<table>
<thead>
<tr>
<th>Philosophy</th>
<th>Phase 1: Post-positivist</th>
<th>Phase 2: Constructivist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical Lens</td>
<td>Bronfenbrenner's Bioecological Model</td>
<td></td>
</tr>
<tr>
<td>Methodological Approach</td>
<td>Mixed Methods</td>
<td></td>
</tr>
<tr>
<td>Methods of Data Collection</td>
<td>Phase 1: Web-Based Questionnaires</td>
<td>Phase 2: Semi-Structured Interviews with AS Dyads</td>
</tr>
</tbody>
</table>

The processes underlying both ASD and puberty involve multilayered interactions between one’s genes and one’s environment. Seeking to understand the overlap of these two phenomena therefore requires a conceptual framework that stresses the interactions between an individual and their environment. This study was approached through the lens of Bronfenbrenner’s Bioecological Model. Bronfenbrenner’s Bioecological Theory of Development has previously been applied to ASD research, particularly those interfacing with natural physiological phenomena (Souders et al., 2009). The Bioecological Model states that human development is influenced by the individual’s environment; proximal processes between the individual and their environment determine developmental outcomes from conception (Bronfenbrenner, 1979). Individuals are not conceived of as passive receptors of their environment, but rather active members within a number of environments: the microsystem, comprised of the family and peers; the mesosystem, with such settings as the classroom; the exosystem, comprised of the community and medical
institutions; the macrosystem, with the political philosophy, cultural customs and values, and social conditions; and the chronosystem, denoting time and the experienced sociohistorical conditions and live events. As proximal processes guide developmental outcomes: poor processes lead to unfulfilled outcomes, while rich processes lead to positive, fulfilled outcomes (Bronfenbrenner, 1979). Given that both ASD and AAM believed to be caused by a combination of genetic and environmental factors (Dvornyk & Waqar-ul-Haq, 2012; Elks et al., 2010; Gajdos, Henderson, Hirschhorn, & Palmert, 2010; Geschwind, 2011; Karapanou & Papadimitriou, 2010; Miles, 2011; Persico & Napolioni, 2013), this model fits both ASD as a disorder and the course of puberty exceptionally well. If the female with ASD is held at the center of this model, variables from the individual herself, her micro-, meso-, exo- and macro-system influence her trajectory through and her experience of puberty. To best understand the proximal processes between the individual and her environment that inform her experience of puberty, we may consider variables located within each system that have been known or hypothesized to influence the course or experience of puberty. For example, variables from the individual herself, such as her age or BMI; from the micro- and meso-systems, the support of her family and peers, or education received on menstruation from a school program or a healthcare provider; from the exo- and macro-system, the attitudes of her culture and society towards menstruation and physical development in individuals with disabilities; and lastly, from the chrono-system, the effects of time in regulating cycles. These layers constantly inform and modulate one another: while a female with ASD may be more likely to have an increased BMI due to food preferences and decreased levels of
activity (individual factors), thus putting her at increased risk for early menarche; the neighborhood where she cannot go out and play due to safety concerns or which lacks affordable, healthy food options (micro- and meso-system factors) inform these very same individual factors and end variables. From this perspective, the relationship and interactions between multiple systems highlight the multitude of factors that can influence the onset and symptoms of puberty, as well as the behaviors of ASD.

**Figure 1.** Bronfenbrenner’s Bioecological Model.

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**Review of Methods**

**Research Design**

As stated above, the study employed an explanatory sequential mixed-methods design, combining cross-sectional data from web-based questionnaires with semi-structured dyad interviews, to garner a detailed picture of the onset, symptoms and experience of menses in females with ASD. Consistent with the explanatory sequential design, the study occurred in distinct phases, an initial Quantitative Phase followed
sequentially by a Qualitative Phase, and was ideal for this study as it (1) allowed qualitative interviews to build on quantitative findings and help explain surprising or unexpected results, and (2) it supported purposive sampling in the Qualitative Phase. As little was known about menses in this unique population at the outset of this study, these methods were selected in order to simultaneously characterize the presentation of menses in broad sample of the population through quantitative methods, while allowing an in-depth exploration of the meaning and process of puberty and menses in these individuals through qualitative interviews.

**Phase 1.** The Quantitative Phase, which targeted Aims 1 and 2, used a cross-sectional, four-group design (AS participant, AS parent, NT participant, NT parent). Individuals completed web-based questionnaires assessing age at menarche, menstrual history, and menstrual symptoms of the daughter participant (i.e., self-report and parent-report), as well as provided data on known and theoretical variables associated with menstrual history and symptoms; specifically, ASD diagnosis, level of exercise, nutrition, BMI, presence of anxiety, use of medication, and socio-demographic variables.

**Phase 2.** The Qualitative Phase of the study, which spoke to Aim 3, consisted of semi-structured interviews with parent-participant dyads (described in more detail in Data Collection, Phase 2). Participants were drawn from the AS group of the Quantitative Phase of the study, using purposive sampling with criteria identified by Phase 1 in order to obtain a heterogeneous sample on (1) age, (2) age at menarche, (3) ASD diagnosis and (4) race/ethnicity. Interviews followed a semi-structured format, with prompts developed following preliminary analysis of the quantitative data and discussions with the study
team to further explore the family’s experience and perception of puberty for their daughter (Interview Guide for Parents and Daughters in Appendices I and J).

**Participants**

In this study, the ‘participant’ identifies the daughter participant according to the criteria below, and the ‘parent’ identifies the parent participant. Parents were those with legal rights and responsibilities to the participant that contributed significant time and energy to promoting the well-being of the participant and was most commonly the biological mother of the participant.

Participants were females under the age of 18 years who had experienced their first menstrual cycle and had at least one cycle within the six months prior to participating. This was to ensure that participants could accurately recall age at menarche and menstrual symptoms, and were not pregnant. Individuals with reading comprehension below the fourth-grade level in English, as well as those with intellectual disability (ID; IQ ≤ 70) were excluded, as questionnaires required the ability to read, understand, interpret and respond to potentially nuanced and dynamic questions. Further, individuals with other diagnosed developmental conditions, such as Down’s Syndrome, or psychiatric conditions, such as Bipolar Disorder, were ineligible to participate, so as to capture effects occurring in the ASD population that are not attributable to other potential etiologies (see Table 6 for complete inclusion and exclusion criteria).

Using convenience sampling, females with ASD and their parents were recruited from *autismMatch*, an online research recruitment site for ASD research based at the Center for Autism Research at the Children’s Hospital of Philadelphia, the *Interactive...*
Autism Network (IAN), an online community for ASD research through a partnership of
Kennedy Krieger Institute and the Simons Foundation in Baltimore, MD, and the
Asperger & Autism Alliance for Greater Philadelphia (ASCEND) and Greater
Philadelphia Autism Society (ASA-Philly) list-servs. NT females and parents were
simultaneously recruited from autismMatch and IAN, as well as using University of
Pennsylvania School of Nursing list-servs. Recruitment began in August 2015 and
continued through May 2016.

Table 6. Inclusion and Exclusion Criteria for The Facing Puberty Study

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Autism Spectrum Disorder (AS) Group</th>
<th>Neurotypical (NT) Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Participant: Female, under 18 years of age, post-menarche, with at least one menstrual cycle in the previous six months. Diagnosis of ASD, Autism, Asperger’s, or Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS)</td>
<td>Participant: Female, under 18 years of age, post-menarche, with at least one menstrual cycle in the previous six months.</td>
</tr>
<tr>
<td></td>
<td>Parent: Legal guardian and caretaker of the participant.</td>
<td>Parent: Legal guardian and caretaker of the participant.</td>
</tr>
<tr>
<td></td>
<td>Participant and Parent: Minimum fourth grade reading level.</td>
<td>Participant and Parent: Minimum fourth grade reading level.</td>
</tr>
<tr>
<td>Exclusion Criteria</td>
<td>Amenorrhea due to natural or medical means, or currently pregnant.</td>
<td>Amenorrhea due to natural or medical means, or currently pregnant.</td>
</tr>
<tr>
<td></td>
<td>Diagnosis of:</td>
<td>Diagnosis of:</td>
</tr>
<tr>
<td></td>
<td>• Intellectual Disability (IQ &lt; 70).</td>
<td>• Intellectual Disability (IQ &lt; 70).</td>
</tr>
<tr>
<td></td>
<td>• Developmental Disability: Cerebral Palsy, Down’s Syndrome or Spina Bifida.</td>
<td>• Developmental Disability: ASD, Cerebral Palsy, Down’s Syndrome or Spina Bifida.</td>
</tr>
<tr>
<td></td>
<td>• Psychiatric conditions: Bipolar Disorder, Schizophrenia.</td>
<td>• Psychiatric conditions: Bipolar Disorder, Schizophrenia.</td>
</tr>
<tr>
<td></td>
<td>• Epilepsy.</td>
<td>• Epilepsy.</td>
</tr>
<tr>
<td></td>
<td>• Genetic Syndrome.</td>
<td>• Genetic Syndrome.</td>
</tr>
</tbody>
</table>

Two hundred and forty seven individuals consented to participate in the study (AS = 121, NT = 126); of these, 194 individuals progressed from consent to participation (AS = 88, NT = 106). The most common reason for individuals to not progress from consent
to participation was lack of consent or assent from both parent and participant (AS = 20, NT = 17; i.e., parent consented, but assent was never received from participant). Towards the end of the open recruitment period, individuals who did not appear to meet criteria attempted to consent and participate in the study (AS = 13, NT = 3). These participants were barred entry from the study on the grounds of potential falsified information. For example, while answers given to the screening questionnaire were correct to automatically move to the consent/assent section, suspicious information was reported in the consent or assent section (e.g., different last names, male first names for daughters, or suspicious email addresses, without clarifications given), geolocations were blocked or identical to other participants, or IP addresses were identical to other participants. Some of these ‘false participants’ did complete the study; their data has been dropped from analysis (AS = 8, NT = 0). Further, despite some participants and parents did not complete the questionnaires (AS = 8, NT = 6), resulting in their corresponding partner being dropped from analysis. See Figure B for participant inclusion chart.

**Phase 1.** One hundred and seventy-two participants and parents completed the web-based questionnaires (ASD = 35, ASP = 37; NTD = 48; NTP = 52); however, only completed pairs were included for analysis in order to meet both Aim 1 and Aim 2 needs. Our final sample consisted of 68 individuals in the AS group (34 parent-participant pairs) and 96 individuals in the NT group (48 parent-participant pairs). This sample did fall short of the goal of 50 pairs per group, resulting in Aim 1 analysis falling just shy of reaching 80% power (see Analysis). As is common with Autism research, the majority of our sample were non-Hispanic White, spoke English as their primary language, from
well-educated, high SES households, and the mother participated with the daughter (see Table 7 for Parent and Participant Demographics). While this does limit the generalizability of the findings, the homogeneity of both samples was a study strength considering factors that influence age at menarche, specifically race and ethnicity. For more detail, see Manuscripts 1 and 2.

Figure 2. Participant Inclusion Flow Chart
**Phase 2.** Ten parent-participant dyads were selected from the 34 dyads in the AS group to be heterogeneous on age, AAM, ASD diagnosis, and race/ethnicity. Participants in this phase of the study were between 14 and 17 years of age and predominately Non-Hispanic White (n = 7, Asian n = 1, Native American n = 2). The participants were diverse on AAM (Early (<10 years) n = 2, Early-Average (11-12 years) n = 3, Late-Average (13-14 years) n = 3, Late (> 14 years) n = 2) and Autism diagnoses (Autism n = 2, PDD-NOS n = 2, Asperger’s Syndrome n = 4, ASD = 2). For more detail, see Manuscript 3.

**Table 7.** Demographics for Parents and Participants

<table>
<thead>
<tr>
<th></th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>14.59 ± 1.94 years</td>
<td>43.01 ± 5.87 years</td>
<td>14.45 ± 1.88 years</td>
<td>45.17 ± 6.03 years</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td>White 33 15</td>
<td>Other / Two + 39 9</td>
<td>Hispanic 7 4</td>
<td>Non-Hispanic 33 4</td>
</tr>
<tr>
<td></td>
<td>30 4</td>
<td>2 1</td>
<td>29 3</td>
<td>30 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other 8 3</td>
<td>3 0</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td>21.92 ± 4.73</td>
<td>27.55 ± 5.80</td>
<td>23.13 ± 4.55</td>
<td>29.60 ± 9.83</td>
</tr>
<tr>
<td><strong>Psychotropic Medication Use</strong></td>
<td>17% 4/48</td>
<td>--- 12/34</td>
<td>35% 34</td>
<td>--- 34</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td>English 46 1</td>
<td>Spanish 44 3</td>
<td>Other 34 0</td>
<td>34 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parent Education</strong></td>
<td>HS/GED - College 12 6</td>
<td>Associate’s 6 6</td>
<td>Bachelor’s 13 12</td>
<td>Master’s 12 6</td>
</tr>
<tr>
<td></td>
<td>Professional/Doctoral 4 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Income</strong></td>
<td>Less than $20,000 1 3</td>
<td>$20-60,000 8 6</td>
<td>$60-100,000 21 11</td>
<td>$100-150,000 10 3</td>
</tr>
<tr>
<td></td>
<td>More than $150,000 7 6</td>
<td>Prefer not to say 1 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Procedure

We received approval from the University of Pennsylvania Institutional Review Board July 27th, 2015. The study was shared with AutismMatch beginning August 2015 and remained available to potential participants through May 2016. Similarly, the study was shared monthly through ASCEND and ASA Philly list-servs beginning October 2015 through May 2016. Following several months of low recruitment, the study team reached out to IAN and actively recruited with their team from March through May 2016.

Once at the study website, participants completed a brief five-question screening questionnaire to ensure eligibility before moving forward to online consent/assent and enrollment. Eligible participants were enrolled in the study after electronically signing the informed consent or assent form. Parent participants consented to their own participation as well as their daughters, and all daughter participants assented to their participation.

Data Collection and Measurement

Phase 1. The web-based component of the study was conducted primarily through Qualtrics, following transition from REDCap in January 2016. The decision to move from REDCap to Qualtrics was driven by the challenges of design in REDCap and participants citing frustration in flow and navigation. Qualtrics allows a more intuitive, user-friendly design and is mobile-friendly, allowing participants to complete Phase 1 from their mobile devices. Participants could complete the study at the time of their choosing, with the recommendation that they complete the questionnaires in a quiet location where they feel comfortable disclosing potentially sensitive information. As females with ASD represent a narrow target population that would be difficult to recruit
to a site-based study, the study team felt using an internet-based survey method would not only help to reach the sample size goals, but also ensure that individuals with diverse backgrounds were able to participate. While there is the potential for socio-economic bias in conducting Internet based research, for this study the opportunities and benefits outweigh this potential negative, as a site-based study would increase burden on the participants. Further, participants may be more comfortable participating in this research in the setting of their choosing, such as at home, as openly discussing puberty and menstruation continues to hold some social stigma and may have caused the participants to feel some embarrassment if asked to discuss the topic with the researcher. Participation through a computer or electronic device (iPad, tablet, etc.) may be preferred by AS participants compared to in-person or paper and pencil survey completion, which may improve validity of our findings.

**Demographics.** All participants began with a demographic questionnaire assessing age, gender, race and ethnicity, height and weight for BMI calculation, primary language, and grade in school. Parents were additionally asked relationship to the daughter participant, level of education, household income, marital status, and daughters’ ASD diagnosis, age at diagnosis, and use of prescription and non-prescription medications. See appendices C and D for daughter and parent versions.

**Menstrual Symptoms.** Onset of menses and menstrual symptoms were measured using a modified version of the Parker-Sneddon Menstrual Disorders of Teenagers (MDOT) Questionnaire (Parker, Sneddon & Arbon, 2010). The MDOT assessed the timing and symptoms of menses through seven structured sections, with the first section
querying date of birth, age at menarche, and height and weight. Section 2 addressed the presentation of a ‘typical’ menstrual cycle, including length of cycle, number of days bleeding, flow characteristics, and regularity of the cycle. Section 3 assessed frequency of menstrual symptoms over the past 12 months; section 4 measured the impact of menstrual cycles on daily activities. Section 5 asked participants to respond to statements about their menstrual cycle, section 6 assessed allergies and intolerances, and section 7 reviewed personal and family history of menstrual disorders. Modifications to the original questionnaire included: adapting terms that are not commonly used in the United States to those that the population will be familiar with, replacing medications (Question #14) with those commonly used in the United States, limiting recall to 6 months from the original 12 months, removing questions (in Section 3 and 5) relating to sexuality and sexual practices, expanding Section 3 to include more emotional and behavioral menstrual symptoms, and expanding Section 7 to include menstrual symptoms and syndromes previously associated with ASD. The MDOT has not been validated, but has been used to explore and describe menstrual symptoms in adolescents worldwide. See appendix E.

Nutrition. The Dietary Screening Questionnaire (DSQ) was used to assess overall nutrition level of the participant, and was completed only by the parent. Developed for the National Health & Nutrition Examination Survey (NHANES) by the National Cancer Institute in 2009, this 26-item screener captures the frequency of consumption of major food groups – fruits, vegetables, dairy, added sugars, whole grains and fibers, and meats – in the past month. While it is considerably shorter than the traditional Food Frequency
Questionnaire used to assess nutrition and therefore sacrifices some accuracy, the DSQ has demonstrated reliability and validity, with responses correlating well with the longer Food Frequency Questionnaire (Thompson et al., 2005). See appendix F.

**Physical Activity.** The Physical Activity Questionnaire – Adolescent (PAQ-A) was used to assess physical activity of the participant and was only completed by the parent. The PAQ-A is a nine-item questionnaire, adapted for parent-report, for adolescents 14 to 19 years old. A score of 1 indicates low physical activity, while a score of 5 indicates high physical activity. The questionnaire has consistently high validity and moderate reliability (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997; Kowalski, Crocker, & Faulkner, 1997; Kowalski, Crocker, & Kowalski, 1997). See appendix G.

**Anxiety Symptoms.** The Screen for Child Anxiety Related Disorders (SCARED), Parent and Child versions, were used to assess anxiety in the participant. The SCARED is a 41-item questionnaire designed to assess for anxiety symptoms in children ages eight to 18 years, yielding a comprehensive score for Anxiety Disorder, as well as sub-scale scores on Panic Disorder, Generalized Anxiety Disorder, Separation Anxiety, Social Anxiety Disorder, and Significant School Avoidance. The SCARED has been used extensively in assessing symptoms of anxiety in youth with ASD, and has been shown to be reliable and have internal consistency (Total score $\alpha = 0.90$, Subscale scores $\alpha = 0.78$-$0.87$; Birmaher, Brent, Chiappetta, Bridge, Monga & Baugher, 1999). See appendix H.

**Phase 2.** Interviews were conducted by the author with participants following completion of Phase 1 for the AS parent-participant pairs. As most individuals were not located in the greater Philadelphia Metropolitan Area, the majority of interviews occurred
by phone with both interviewer and interviewees in quiet, private locations (n = 8); one interview was in-person and one interview was conducted over Skype.

Interview guides (see Appendices I and J), consisting of questions and probes to stimulate discussion and conversation, were developed with the research team following a preliminary analysis of the Quantitative Phase for AS group, using findings from the questionnaires to generate areas for further inquiry. Interviews were recorded using the Olympus 142665 DM-620 SLV Voice Recorder, with the Olympus TP-8 Telephone adaptor for phone interviews; field notes were recorded during interviews and are included with transcripts. In an effort to meet participants’ needs, interviews were offered to either parent or participant first, with participants being allowed to gain familiarity of the interview process by listening to the parent’s interview. Additionally, parents were allowed to support their child through the interview if needed. Interviews with parents typically lasted 30-40 minutes and interviews with participants approximately 15-20 minutes.

**Data Management**

Qualtrics was used as a central resource for data collection, with management and data cleaning in Excel for Phase 1 of this study. Qualtrics is a web application developed with HIPAA-Security guidelines with features such as data encryption and is recommended by the Office of Human Research to University of Pennsylvania researchers. It provides an intuitive interface for data entry, geolocation and IP tracking, and automated export procedures for smooth data downloads to common statistical packages. Data from Part 1 was downloaded to Excel for data cleaning and coding, then
analyzed using Stata on a private drive on a password-protected computer in a locked room at the University of Pennsylvania, School of Nursing. All participants were assigned a coded identification number in Excel and data was de-identified from any and all personally identifying information. Only research personnel had access to the data in Qualtrics, Excel or Stata; the author was responsible for managing and maintaining the quantitative database.

All interviews were digitally recorded using the Olympus 142665 DM-620 SLV Voice Recorder, with the Olympus TP-8 Telephone adaptor for phone interviews. Recordings were downloaded to a password-protected computer for back up and ease of transcription. The author transcribed recordings from the recording verbatim into Microsoft Word documents. Transcripts were de-identified from any names or personally identifying information (such as addresses or dates of birth), checked for accuracy and entered into NVivo 11, the software package used for qualitative analysis (QSR International Pty Ltd, 2012). An NVivo database was developed in order to store data, develop a coding schema, code content, and track emerging themes. The author developed the coding structure and a codebook in conjunction with her expert committee, with codes developed *a posteriori* from open coding selected transcripts of both parents and participants. All documents and data were stored on password-protected computers; original recordings and field notes were de-identified and subsequently secured at the University in a locked cabinet in a locked room compliant with IRB protocols.

**Analysis**

Analysis began with a descriptive comparison of demographic variables between
AS and NT groups, according to participant report, using StataIC 14 (StataCorp, 2015). Stata was used for all quantitative analyses, whereas NVivo was used for qualitative data. In explanatory sequential mixed-methods research, quantitative and qualitative data are analyzed separately, providing a straightforward, clear delineation that lends itself to a three-paper dissertation structure, with results connected in the final stage of the study for discussion.

**Aim 1.** The primary goal of this study was to describe the onset and symptoms of menses in females with ASD compared to their NT peers. To meet this aim, we calculated the individual’s age at menarche as reported on the MDOT ([date at menarche – date of birth]/365.25 = age at menarche in years) from both the participant and the parent. Participant AAM is reported for Aim 1, with parent report of AAM in Aim 2; the mean, median, standard deviations, interquartile ranges were computed for both the AS and NT groups. While we sought to reach sample sizes of 50 per group, which was sufficient to achieve 80% power, our recruitment fell short of this goal. However, a post hoc power calculation for the one-way ANOVA comparison of AAM by group in Manuscript 1 revealed that on the basis of the means and between-group comparison effect size observed in the study (d = 0.37), the n = 79 achieved 77% power, just shy of the recommended 80% (Alpha = 0.05). Given the limitations faced by the researcher, the power was deemed sufficient for this study.

Reported length of cycle from both participant and parent were reported with descriptive statistics, including mean and standard deviation for both the AS and NT groups. For regularity, the raw n of participants who report a regular or irregular cycle, as
well as the percent of the AS and NT groups was reported (i.e., 60% of NT participants report a regular cycle). For number and severity of symptoms, Count and Summary scores were calculated for pre-menstrual, dysmenorrhea physical, emotional and behavioral menstrual symptoms (as show in Appendix B). For Count variables, mean, standard deviation and ranges for both AS and NT groups are reported where appropriate. For Summary variables, which represent the ‘burden’ of symptoms, an average of the symptoms experienced of the total symptoms within the category, with 0 indicating No Symptoms, 0.01-0.33 indicating Low Symptom Burden, 0.34-0.66 indicating Moderate Symptom Burden, and 0.67-1.00 indicating High Symptom Burden. The top six most frequently reported menstrual symptoms, with means and standard deviations reported, were also reported. Lifestyle Interference Scores are reported, for Activities and for Symptoms, by mean and standard deviation by group. Lastly from the MDOT, frequencies and percentages of participants’ knowledge of and familial history of gynecologic disorder were reported by group.

**Aim 2.** Characterize the differences in self-report and parent-report of onset of menarche and menstrual symptoms between females with ASD and their Neurotypical peers.

To address this aim, the mean and standard deviations for the variables noted in Aim 1 for the parents and participants in both the AS and NT groups separately. Through these analyses, a sense of how perceptions and reporting of menses varied between participants and their parents was sought. Variables were compared using matched t-tests to assess differences between parent and participant reports.
**Aim 3.** Explore the experience of menses for females with ASD, Neurotypical females, and their primary parent through semi-structured interviews.

Interviews from participants and parents were analyzed using a qualitative descriptive approach of thematic analysis. Interviews were transcribed verbatim from the primary recording device, with all field notes taken by the research included at the end of each corresponding interview. Analysis was conducted according to the steps outlined by Creswell and Clark for explanatory sequential mixed-methods studies. Following preparation of the qualitative data, the researcher read through all of the transcribed interviews and field notes, marking notes to guide development of the qualitative codebook and subsequent analysis in the margins. The codebook used for analysis was developed from this initial exploration, as well as from notable findings from Phase 1 of the study, and served as a mechanism to organize data, ensuring agreement across coders, and served to inform development of themes. Once codes were identified and set, the transcripts and notes were coded, and codes organized by thematic categories. Thematic categories were interpreted in Manuscript 3. Qualitative validity was ensured through triangulation of data and expert review.

Finally, qualitative data was merged with quantitative data from Manuscript 1 and 2 for a connected mixed methods analysis in Chapter 5 (Creswell & Plano Clark, 2011). As noted by Creswell and Clark (2011), inferences that are drawn from each phase of the study inform the merged analysis and generation of meta-inferences that are drawn at the conclusion of the study. Because in explanatory sequential designs qualitative data may provide a more detailed understanding of the question at hand, these meta-inferences
drawn from both components of the study unify and clarify the study as a whole (Creswell & Plano Clark, 2011). Validity was assured by the quality and rigor of the study design, by fidelity to procedures, and by interpretive rigor (Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2009).

**Limitations and Assumptions**

There are several limitations to this study. First, the use of web-based questionnaires used for Phase 1 of this study may have led to sampling bias and nonresponse. While some individuals may have been excluded from this study due to lack of Internet access, we believe this number to be negligible within the population of interest. To mitigate nonresponse and missing data (from participants skipping questions), pop-up reminders appeared at the end of each section if a question is missed. This allowed participants to return to any unanswered question if it was accidentally omitted, but not force participants to respond to any question they do not wish to answer. No questions forced a response from participants.

Research has shown that web-based methods of data collection yield comparable results to traditional mail-in pencil and paper questionnaires (Fitzpatrick & Montgomery, 2004; Fleming & Bowden, 2009; Greenlaw & Brown-Welty, 2009; Hewson, Yule, Laurent, & Vogel, 2003; Leece et al., 2004). Additionally, the use of web-based data collection allows the researcher to reach a larger population for sampling, reduce study cost and participant burden, and streamline collection and analysis of results (Cook, Heath, & Thompson, 2000; Dillman & Bowker, 2001; Glasgow et al., 2007; Hewson et al., 2003). Given the social impairments of ASD, it is believed that participants may be
more comfortable answering personal questions through the computer interface, compared to pencil and paper methods with a researcher nearby. The study inclusion and exclusion criteria were strict and prohibited participation of individuals with cognitive impairment or intellectual disability. While rates of ID in females with ASD are relatively high (approximated 40% in the United States; Christensen, 2016) thus lowering the generalizability of this study to females with ASD as a group, the results from Aim 2 serve to guide future studies on the inclusion of individuals with cognitive impairment and ID, for which parent-report may be the only feasible mechanism of data collection.

As originally planned, the research team discussed opening the study to parents participating alone in January of 2016. While half the target sample size had not been reached at this point, the research team decided not to open the study to parents participating alone in order to meet Aim 2. No difficulties were anticipated for participant engagement with the web-based component of the study, though a novel platform and novel questionnaires were used. The MDOT has not yet been analyzed for reliability and validity in this or any population. However, the MDOT offers the most comprehensive assessment of menstrual symptoms and impact on daily functioning identified by the PI, making it well suited to generate a detailed quantitative description of the presentation of menses in females with ASD. As puberty and menses in ASD have received little attention in the literature to date, it was deemed acceptable to use a non-validated measure given the depth of the questionnaire and the quality of data it yielded.

Human Subjects Considerations

Study Approval
This study sought and received IRB approval from the University of Pennsylvania. No study procedures were initiated until approval was received on July 27th, 2015.

**Informed Consent and Assent**

While anonymous survey research is typically exempt from review and consent, this study involved vulnerable populations identified by the NIH (women, children), as well as individuals with disability, and collected personally identifying information for AS participants and parents to be contacted for Phase 2 of the study. As participants were below the age of consent (18 years), we required consent from the ‘parent’ (parent or legal guardian) and assent from the ‘participant’ in the form of electronic signatures. Records of consent and assent were stored separately from questionnaire data and not associated with the data beyond the study ID number. Records linking participant to their study ID were destroyed at the conclusion of the study.

**Inclusion of Women, Minorities and Children**

Women comprised the vast majority of study participants, as parent participants were predominately mothers. Half of the participants in this study were under the age of 18, as stipulated by inclusion criteria for the participant groups. Recruitment of participants did not discriminate based on an individual’s race, though, as anticipated, fewer minorities participated in this research, possibly due to diagnostic differences in ASD (Mandell et al., 2009).

**Privacy and Confidentiality**

Some personal identifying information (e-mail addresses and phone numbers)
were collected in this study to allow for selected participants from Phase 1 to be contacted for Phase 2. Contact and personally identifying information were removed following study completion. Every parent and participant was assigned a coded subject number that connected with the data collected, but was not able to be traced back to an individual participant. Data was stored in accordance with University of Pennsylvania policies. Individuals and organizations that had access to this data include the researcher and authorized members of the Office for Human Research Protections at the University of Pennsylvania. The results of this study will be discussed and shown at meetings, and published in journals. Private identity will not be included in any dissemination of findings.

**Potential Risks and Protection against Risks**

This study posed minimal risk to participants and their parents. While some questions addressed sensitive, personal information that could potentially have made participants feel uncomfortable, there were no questions specifically related to topics of sexuality, sexual behaviors, or abuse. As there was some concern that individuals, both participants and parents, may have experienced some psychological distress as the result of discussing puberty and menses during Phase 2 interviews, a Psychiatric-Mental Health Nurse Practitioner with experience working with individuals with ASD and their families was available should any issues arise that participants wished to discuss further. One parent reported a history of abuse in her daughter, but did not wish to follow up with the NP.

Participants were reminded that they did not have to answer all questions and
were allowed to cease participation in the study at any time without repercussion. However, given that the content of the study may have spark discussions or thoughts related to concepts of womanhood, including menstruation and sexuality, resources appropriate to both the ASD and NT population were provided to participants at the conclusion of the study, should they have further questions or interest in the topics covered in this study. For females with ASD, this includes the Adolescent section of AutismSpeaks.org and their Transitions Tool Kit; for NT females, this includes the Office of Adolescent Health of the U.S. Department of Health & Human Services.

**Potential Benefits**

This study sought to improve our understanding of puberty, specifically menses, in females with ASD. The knowledge gained from this study will help to direct future research and help clinicians and parents of females with ASD to open a dialogue on menses in this population.

**Ethics of Participant Payment**

Participants selected a $10 e-gift card of their choice from a list of 25 businesses (i.e., Amazon, Starbucks, Panera) in compensation for the completion of Phase 1 questionnaires. As Phase 2 included a significant increase in burden in time, effort, and potentially travel, both parents and participants were compensated for their participation at the rate of $25 per individual, also in the form of an e-gift card of their choice, in accordance with the Wage Payment Model put forth by Dickert and Grady (Dickert & Grady, 1999). According to this model, participation in research requires little skill, but is burdensome in terms of time and effort and may include some risk. As such, all
participants were reimbursed at the same level, based on calculations of study demands and equivalent labor hourly wages. For Phase 2 interviews, participants engaged in 30 to 60 minute interviews with the researcher; as this was demanding in terms of time and energy, and potentially challenging topics were addressed, compensation at the rate of $25 per individual was appropriate.

**Importance of Knowledge Generated**

As noted previously, limited research exists on the course of puberty in females with ASD and none had addressed this critical life point from a qualitative standpoint. The published literatures has suggested this population may be at increased risk for both precocious puberty and primary amenorrhea, and the presentation of menses may be more severe than in Neurotypical peers (Burke et al., 2010; Hamilton et al., 2011; Hergüner & Hergüner, 2016; Ingudomnukul et al., 2007; Knickmeyer et al., 2006; Pohl et al., 2014; Whitehouse et al., 2011). The overall goal of this study was to address the identified gaps in the literature and to improve the understanding of the course that puberty may take in this population, as well as the unique experience of puberty for ASD in females.
Key Terms

*Precocious puberty*: Onset of menses before the 8\textsuperscript{th} birthday.

*Primary amenorrhea*: Absence of menses by the 16\textsuperscript{th} birthday.

*Early menarche*: Menarche less than or equal to 11 years of age.

*Late menarche*: Menarche greater than or equal to 14 years of age.

*Regular menstrual cycles*: Cycle length of 22-35 days with consistent length of time between periods.

*Irregular menstrual cycles*: Cycle length less than 22 or more than 35 days, or with inconsistent length of time between periods.

*Menses*: The time of menstruation.

*Amenorrhea*: Absence of a menstrual period for 90 days or longer, not due to pregnancy.

*Dysmenorrhea*: Pain during menstruation.

*Menorrhagia (heavy menstrual loss)*: Use of 4 or more fully soaked pads a day for any duration during the menstrual periods.

*Hypomenorrhea (light menstrual bleeding)*: Less than 1 fully soaked pad or use of panty liner being sufficient for protection.

*Premenstrual Syndrome (PMS)*: A grouping of symptoms with onset in the second half of the menstrual cycle (14+ days from the first day of the last period) that are relieved within 1-2 days after onset of menses. Symptoms include: acne; swollen or tender breasts; fatigue; difficulties sleeping; changes in appetite; indigestion, bloating, constipation or diarrhea; cramps; headache or backache; joint or muscle pain; anxiety or
depression; mood swings, irritability or tension; difficulties concentrating or with memory.

*Premenstrual Dysphoric Disorder (PMDD)*: A syndrome of depression symptoms brought on by monthly hormonal fluctuation. Severe and debilitating condition, PMDD comprises of five or more of the following symptoms, including one mood-related symptom: fatigue; feelings of hopelessness or sadness, possible suicidal thoughts; little to no interest in usual activities or relationships; feelings of tension, anxiety, or panic attacks; changes in appetite, food cravings or binge eating; mood swings with periods of crying; difficulties sleeping; irritability or anger; bloating, breast tenderness, headaches, joint or muscle pain; difficulties concentrating. Symptoms begin in the week prior to menses and typically improve within 1-2 days after the onset of menses.
MANUSCRIPT 1.

Onset and Presentation of Menses in Females with Autism Spectrum Disorder Compared to Neurotypical Peers
Abstract

This cross-sectional descriptive study investigated the differences in age at menarche (AAM) and menstrual presentation between females diagnosed with Autism Spectrum Disorder (ASD) and Neurotypical controls using web-based self-report on the Menstrual Disorders of Teenagers Questionnaire (MDOT). Females with ASD from multiplex families reported significantly earlier AAM (n = 8, M = 11.01, SD = 1.10), compared to females from simplex families (with ASD: n = 24, M = 12.42, SD = 1.38; Neurotypical with an ASD sibling: n = 34, M = 12.18, SD = 1.34), and Neurotypical controls with no family history of ASD (n = 12, M = 12.86, SD = 0.94). No differences were observed in characteristics of the menstrual cycle or menstrual symptoms across groups.

Keywords: Autism Spectrum Disorder, Females, Menarche, Menstruation, Menstrual Symptoms
Introduction

Puberty marks the transition from childhood to adulthood and is a period of physical, cognitive and social growth. For children with Autism Spectrum Disorder (ASD), a neurodevelopmental disorder characterized by impairments in social communication and interaction, as well as restricted, repetitive patterns of behavior or interests (Christensen, 2016), puberty may pose unique challenges as the social, cognitive and developmental growth fundamental to puberty interacts with the social, developmental and behavioral impairments of ASD. Females with ASD may face additional difficulties with the onset of menses, or menstrual cycle. Menarche, the first menstrual cycle, and menses are central components of puberty and womanhood in Western cultures (Beausang & Razor, 2000; Rembeck et al., 2006). Further, they have been significantly associated with serious health concerns across the lifespan. Early age at menarche has been associated with increased risk for breast cancer (Collaborative Group on Hormonal Factors in Breast Cancer, 2012; Petridou et al., 1996; Stoll et al., 1994), cardiovascular diseases (Feng et al., 2008; Lakshman et al., 2009), increased BMI and abdominal type obesity (Freedman et al., 2003; Okasha, McCarron, Smith, & McEwen, 2001), insulin resistance and type 2 diabetes (He et al., 2010; Remsberg et al., 2005), as well as adolescent depression and anxiety (Joinson et al., 2011; Kaltiala-Heino et al., 2003; Mendle, Turkheimer, & Emery, 2007; Stice et al., 2001), substance abuse and dependence (Stice et al., 2001), earlier sexual debut (Andersson-Ellström, Forssman, & Milsom, 1996; Kaltiala-Heino et al., 2003), resulting in earlier exposure to and
increased risk for sexual transmitted infections (Coker et al., 1994; Kaestle, Halpern, Miller, & Ford, 2005).

Broadly, the gynecologic health of women with physical and cognitive disabilities has been overlooked and understudied (Burke et al., 2010). To date, only seven studies have addressed the onset of menses, symptoms of the menstrual cycle or syndromes related to women’s health among females with Autism Spectrum Disorder. These studies have reported mixed findings for age at menarche (AAM; Burke et al., 2010; Hamilton et al., 2011; Knickmeyer et al., 2006; Whitehouse et al., 2011), elevated rates of precocious puberty (Pohl et al., 2014), and elevated rates of both early onset menarche and primary amenorrhea (Ingudomnukul et al., 2007; Knickmeyer et al., 2006). In addition to atypical onset, these studies elucidate a pattern of increased menstrual symptoms and syndromes associated with the menstrual cycle, including dysmenorrhea, irregular menstrual cycles, menorrhagia, hirsutism, premenstrual syndrome or premenstrual dysphoric disorder, and polycystic ovarian syndrome (Ingudomnukul et al., 2007; Pohl et al., 2014). However, these studies have limited generalizability due to small sample sizes (Burke et al., 2010; Knickmeyer et al., 2006), the use of Neurotypical participants grouped by scoring on autism questionnaires as a proxy population for those with ASD (Hergüner & Hergüner, 2016; Whitehouse et al., 2011), lack of Neurotypical control groups (Burke et al., 2010; Hamilton et al., 2011), and lack of control for other variables known to be associated with AAM (Burke et al., 2010; Hamilton et al., 2011; Knickmeyer et al., 2006). Furthermore, they lack common terminology and definitions, resulting in a literature base that is conflicting and limited.
Beyond representing a critical predictor of health concerns across the lifespan, onset and symptoms of the menses may be particularly difficult for females with ASD to cope with and manage. Not knowing when to expect her period may complicate planning and management, the arrival of a period unexpectedly may lead to increased behavioral problems when her anticipated schedule changes, painful periods may interfere with her ability to participate in or perform activities of daily life, and heavy flows may be difficult to manage in such a way that does not interfere with her daily schedule, nor runs the risk of insufficient protection and resulting embarrassment or social ostracism. While menses may interfere with daily activities in Neurotypical females, the increased burden of planning and adjusting to menses may be challenging for females with ASD and their families. The unpredictability of menarche and menses, particularly in the early menstrual years, may pose unique challenges to those with ASD. The need for sameness, routine and a measure of control that is a hallmark of the disorder is unlikely to interact well with a time marked by irregularity (ACOG Committee on Adolescent Health Care, 2006; Adams Hillard, 2008) and increasing symptom burden (Adams Hillard, 2008; Clayton, 2008; Hickey & Balen, 2003). Further, sensory differences that are often associated with ASD (Leekam, Nieto, Libby, Wing, & Gould, 2007; Rogers, Hepburn, & Wehner, 2003) may interfere with the selection and use of appropriate hygiene products and clothing, notably bras, for their developing bodies. The interference and severity of these issues during the teenage years in females with ASD have ramifications beyond their menstrual health and must be addressed to fully support and care for these individuals.
While the onset and symptoms of menses are beginning to be documented, the effects of menses on daily life and functioning with ASD have yet to be described. The aim of this paper is to not only examine the onset, characteristics and symptoms of menses for females with Autism Spectrum Disorder, but to clarify the impact of menses on activities of daily life, compared to Neurotypically developing peers.

Methods

Facing Puberty Study Procedure

This study reports the findings from the daughters participating in the cross-sectional, descriptive Quantitative Phase of the Facing Puberty Study, an explanatory sequential mixed-methods study addressing the onset, presentation and experience of menses for females with Autism Spectrum Disorder compared to Neurotypical peers through web-based questionnaires and semi-structured dyad interviews with parents and daughters. From August 2015 through May 2016, families with and without a diagnosis of an Autism Spectrum Disorder (including diagnoses of Autistic Disorder, Asperger’s Syndrome, or Pervasive Developmental Disorder-Not Otherwise Specified) were recruited predominately through two autism research registries: autismMatch located at the Center for Autism Research at the Children’s Hospital of Philadelphia in Philadelphia, PA and the Interactive Autism Network (IAN), a partnership of Kennedy Krieger Institute and the Simons Foundation, in Baltimore, MD. Eligible participants were females with and without a diagnosis of an ASD (1) under the age of 18 years, (2) had begun menstruating, (3) with at least one menses in the six months prior to participating, and one of their parents, creating a parent-participant dyad. Due to known
and potential influences on age at menarche, daughters could have no co-morbid diagnoses of Intellectual Disability, Cerebral Palsy, Down’s Syndrome, Spina Bifida, Bipolar Disorder, Schizophrenia, Epilepsy or known genetic syndrome. Proficiency in reading English, noted by a fourth-grade reading level, was necessary for both parent and daughter to understand and answer the web-based questionnaires. The study website was supported by Qualtrics. Qualtrics offers an intuitive, user-friendly design for online research, which meets the strict security standards required by Human Subjects Research while allowing individuals to access and participate in research through their technology of choice. A five-question screener at the home page of the study ensured participants reported meeting the above criteria before moving to the consent or assent section. Parental consent and child assent were obtained from each parent-participant dyad.

Once both parent and daughter participants had consented, participants were emailed individualized links to the password-protected study website. All participation for the Quantitative Phase of the Facing Puberty Study was online through the study website. There, all participants were asked to complete a demographic questionnaire, a modified version of the Parker-Sneddon Menstrual Disorders of Teenagers Questionnaire (MDOT; Parker, Sneddon, & Arbon, 2010) and the Screen for Child Anxiety Related Disorders Questionnaire (SCARED; Birmaher et al., 1997; Birmaher et al., 1999). Parents were additionally asked to complete the Physical Activity Questionnaire for Adolescents (PAQ-A; Kowalski et al., 1997; Kowalski et al., 1997) on their daughter’s activity habits. Questionnaires took approximately 20 minutes to complete for daughters and 30 minutes for parents. Upon completion of the Questionnaires, participants were
invited to select a $10 e-gift card for their participation. For the majority of participants, engagement with the study ended with completion of the questionnaires; ten parent-participant dyads with Autism Spectrum Disorder were selected for semi-structured interviews that explored themes identified by a preliminary exploration of finding from the questionnaires and are discussed in Manuscript 3. Approval to conduct this study was obtained from The Institutional Review Board at the University of Pennsylvania.

Areas of Exploration

Age at Menarche. Month and year at menarche was reported retrospectively in Section 1 of the MDOT. Participant’s age at menarche was calculated using their date of birth and midpoint of the reported month and year that menses began (e.g., [Menarche (1/15/16) – DOB (10/8/00)]/365.25 = 15.3 years at menarche). Participants were further described as having Early Menarche if the reported age at menarche was less than or equal to 11 years and Late Menarche if the reported age at menarche was greater than or equal to 14 years; these ages are commonly used for reporting early and late menarche (Freedman et al., 2003; Gaudineau et al., 2010; Ho & Kung, 2005; Johansson & Ritzen, 2005; Varraso, Siroux, Maccario, Pin, & Kauffmann, 2005). Less than 10% of females in the United States begin menstruating before age 11 and more than 90% have begun by age 14 (Chumlea et al., 2003).

Covariates. Key variables that have previously been shown to be associated with age at menarche were collected in the participant and parent demographic questionnaires, including parent and daughter participants race and ethnicity, height and weight for BMI calculation for the daughter, as well as family’s income (eight-point scale of increasing
amounts), parental education (five-point scale from High School/Some College to Professional/Doctoral Degree), mother’s age at menarche, maternal age at pregnancy, abnormal maternal weight gain during pregnancy (Yes for < 10 lbs. or > 40 lbs., No for 10-40 lbs.), presence of preeclampsia during pregnancy (Yes or No), as well as participant’s level of activity from the PAQ-A. As a high proportion of NT participants had a sibling with a diagnosis of an ASD (74%), this was also included as a covariate (Yes or No). Recruitment strategies primarily through autism research databases noted above likely led to this ‘atypical’ control group.

**Characteristics and Symptoms of the Menstrual Cycle.** Characteristics and symptoms of the menstrual cycle were collected in Sections 2 and 3 of the MDOT. Cycle length, defined as the first day of one period to the first day of the next (typically 20 to 45 days in adolescent females; Adams Hillard, 2008), and period length, defined as the number of menstrual days (typically 3-7 days; Adams Hillard, 2008), as well as regularity of cycle and presence of clots were assessed. Participants reported their level of pain related to their menstrual cycle on a scale from 0 to 10, with scores of 1-3 indicating ‘Mild’ pain, 4-7 ‘Moderate’ pain, and 8-10 ‘Severe’ pain, as well as use of over-the-counter (OTC) pain medication and its’ effectiveness. In Section 3, participants reported presence of symptoms by ‘No or Never’, ‘Just before a period’, ‘At the time of my period’, ‘Any time of the month’, ‘All the time’ or ‘Sometimes’. Count and summary scores for Pre-Menstrual Symptoms, Physical Menstrual Symptoms, Behavioral Menstrual Symptoms, Emotional Menstrual Symptoms and Dysmenorrhea were created from responses to symptoms experienced in relation to the participant’s monthly cycle in
Section 3 (see Table 1). Count scores reflect the total number of symptoms reported by the participant at the appropriate time (i.e., ‘Just before a period’ for Pre-Menstrual Symptoms and ‘At the time of my period’ for menstrual symptoms), while Summary scores reflect the symptom burden, an average of the symptoms experienced of the total symptoms within the category, with 0 indicating No Symptoms, 0.01-0.33 indicating Low Symptom Burden, 0.34-0.66 indicating Moderate Symptom Burden, and 0.67-1.00 indicating High Symptom Burden. For example, if a participant reported no symptoms of dysmenorrhea at the time of her period her Dysmenorrhea Count would be ‘0’ and her Dysmenorrhea Summary Score would be ‘No Symptoms’; conversely, if she experienced four of the seven symptoms included in the Dysmenorrhea category, her Count would be 4 and her Summary Score would be ‘Moderate Symptom Burden’. The top six symptoms reported by participants were explored: (1) pelvic pain: cramping at the time of a period, (2) changes in mood at the time of a period, (3) changes in mood just before a period, (4) bloating at the time of a period, and a tie for (5) with feeling irritable at the time of a period and (6) changes in appetite at the time of a period.

**Table 1. Menstrual Symptoms by Category**

<table>
<thead>
<tr>
<th>Pre-Menstrual Symptoms</th>
<th>Physical Menstrual Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
<td>Vomiting</td>
</tr>
<tr>
<td>Constipation</td>
<td>Diarrhea</td>
</tr>
<tr>
<td>Headaches</td>
<td>Indigestion</td>
</tr>
<tr>
<td>Breast Tenderness</td>
<td>Acne</td>
</tr>
<tr>
<td>Changes in sleep</td>
<td>Changes in appetite</td>
</tr>
<tr>
<td>Lower back pain</td>
<td>Feeling down or depressed</td>
</tr>
<tr>
<td>Difficulties concentrating</td>
<td>Irritability</td>
</tr>
<tr>
<td>Anxiety related to the period</td>
<td>Changes in mood</td>
</tr>
<tr>
<td>Tearfulness</td>
<td></td>
</tr>
<tr>
<td>Nausea</td>
<td>Vomiting</td>
</tr>
<tr>
<td>Bloating</td>
<td>Diarrhea</td>
</tr>
<tr>
<td>Constipation</td>
<td>Indigestion</td>
</tr>
<tr>
<td>Pelvic pain</td>
<td>Lower back pain</td>
</tr>
<tr>
<td>Aching outside the vagina or down the legs</td>
<td>Thrush</td>
</tr>
<tr>
<td>Headache</td>
<td>Dizziness</td>
</tr>
<tr>
<td>Breast pain or tenderness</td>
<td>Acne</td>
</tr>
</tbody>
</table>
Impact on Lifestyle. From Section 2, questions assessing the frequency, duration and reasoning for missing school due to a menstrual cycle were used to understand impact on the participant’s lifestyle. Additionally, section 4 of the MDOT assessed impact of menses on various activities of daily life and the impact of specific symptoms on activities of daily life, on a scale from 0 to 10, as well as whether interference occurred with some, most or all periods. Interference is reported by activity and symptom.

Knowledge and Family History. The final section of the MDOT briefly assesses knowledge and family history of the participant for several common gynecologic disorders, including polycystic ovarian syndrome (PCOS), endometriosis, pelvic inflammatory disease, fibrocystic breasts and dysmenorrhea.

Statistical Analysis

Analyses were conducted using StataIC v14.1 (StataCorp, 2015). Age at menarche was tested for univariate normality. Statistical analysis used to compare participant groups on the variables noted above. Categorical data were assessed using chi-square analysis, continuous data with one-way ANOVA with post-hoc Bonferroni adjustment where appropriate. Finally, one multiple regression model was analyzed to
understand the role of predictor variables noted in *Areas of Exploration: Covariates* on AAM. For all tests, a *p*-value of $< 0.05$ was considered significant and a *p*-value of 0.05-0.10 was considered moderately significant.

**Results**

**Participants**

Of the 380 individuals who accessed the study, 247 met criteria for the study determined by a five-question screener, and consented or assented to participate. Fifty-three of these consented individuals lacked consent or assent from their corresponding parent or daughter to complete the dyad, and were excluded from participation. Of the 194 individuals who were emailed an individualized link to the study, 180 accessed and completed the questionnaires. Sixteen of these were removed from analysis due to lack of dyad data (e.g., the parent completed the study, while their daughter did not), incomplete questionnaires (e.g., lacking answers to at least one full questionnaire), or suspected falsified data (e.g., reporting a date of birth that would exclude the daughter participant from the study). This resulted in 164 individual completed questionnaires, reflecting 82 complete parent-participant dyads; 34 dyads in the Autism Spectrum (AS) group, and 48 dyads in the Neurotypical (NT) control group. Participants came from families with no history of ASD, simplex families, in which one individual has a diagnosis of ASD, and multiplex families, in which multiple individuals have a diagnosis of ASD. Here, multiplex families are defined as the daughter participant and a sibling reporting diagnoses of ASD. Again, this analysis addresses only the daughters participating in the study; hereafter solely referred to as the “participant”.

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Table 2 summarizes the demographic characteristics of the study participants. There were no significant differences between groups in terms of age, ethnicity, BMI, or grade in school. Participants in the NT group were more likely to report being ‘Other/Two or more’ races (31%) and were significantly more likely to have a sibling with a diagnosis of an ASD (74%) compared to the AS group (12%, 25%, respectively; \( \chi^2(1) = 4.24, p = 0.04; \chi^2 = 18.78, p = 0.00 \)). As the NT group represents an ‘atypical’ control group, given the high proportion of those with siblings diagnosed with an ASD, the decision was made to analyze variables by the following groupings: NT with no family history of an ASD (NT, n = 12), those from simplex families, NT with an ASD sibling (NT:AS for ‘Autistic Sibling’, n = 35) and AS with no ASD sibling (AS, n = 24), and multiplex families of AS with ASD sibling (AS:AS, n = 8). Sample size varies by analysis due to some missing data, and is noted for each analysis.

Table 2. Participant Demographics

<table>
<thead>
<tr>
<th></th>
<th>NT (n = 48)</th>
<th>AS (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>M ± SD</td>
<td>14.59 ± 1.94 years</td>
<td>14.45 ± 1.89 years</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>10.24 – 17.87</td>
<td>11.25 – 17.85</td>
<td></td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
<td></td>
<td>( \chi^2(1) = 4.24 ) ( p = 0.04 )</td>
</tr>
<tr>
<td>White</td>
<td>33</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Other / Two or more</td>
<td>15</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Ethnicity</strong></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Non-Hispanic/Latina</td>
<td>7</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hispanic/Latina</td>
<td>33</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td>21.92 ± 4.73</td>
<td>23.27 ± 4.55</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Psychotropic Medication Use</strong></td>
<td>17%</td>
<td>35%</td>
<td>( \chi^2(1) = 3.74 ) ( p = 0.05 )</td>
</tr>
<tr>
<td>Use</td>
<td>8/48</td>
<td>12/34</td>
<td></td>
</tr>
<tr>
<td><strong>Grade</strong></td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Kindergarten-4th</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5th-8th</td>
<td>24</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>9th-12th</td>
<td>22</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>College</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Home Schooled</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
Age at Menarche

Age at menarche was normally distributed ($M = 12.25 \pm 1.33$, Range $9.52 -15.12$; Skewness/Kurtosis test for Normality $\chi^2 = 0.85, p = 0.65$). A one-way ANOVA revealed a significant effect of group on AAM ($F(3,73) = 3.62, p = 0.02$). Figure 2 illustrates that females from multiplex families (AS:AS) reported significantly earlier AAM ($M = 11.01$, SD $= 1.10$, Range $= 9.51 – 13.00$ years) compared to females from simplex families (NT:AS: $M = 12.18$, SD $= 1.34$, R: $9.94 - 15.12$ years; AS: $M = 12.42$, SD $= 1.38$, Range $= 9.6 – 15.04$ years) and those with no family history of ASD (NT: $M = 12.86$, SD $= 0.94$, Range $= 11.9 - 15.07$ years). The effects size for this comparison was moderate (partial $\eta^2 = 0.13$) and Bonferroni post-hoc tests revealed a significant difference in AAM between NT and AS:AS groups ($p = 0.01$), a nearly significant difference in AAM between AS and AS:AS groups ($p = 0.05$), no significant different between AS:AS and NT:AS groups ($p = 0.13$), or between AS to NT:AS, AS to NT, and NT to NT:AS groups ($p = 1.00, p = 1.00, p = 0.70$). Of note, a study by Hamilton and colleagues (2011) reported AAM varying significantly across the previous ASD diagnostic categories. We found a similar trend with participants diagnosed with Autism experiencing AAM earliest (11.32 years) followed by Asperger’s (12.30 years), PDD-NOS (12.59 years) and ASD (12.92 years); however, this trend was only moderately significant ($p = 0.09$).

A Chi-square test revealed that the percentage of participants who experienced

<table>
<thead>
<tr>
<th>ASD Diagnosis</th>
<th>12</th>
<th>6</th>
<th>10</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PDD-NOS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asperger’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASD Sibling</td>
<td>74%</td>
<td>25%</td>
<td>$\chi^2 = 18.78$</td>
<td></td>
</tr>
</tbody>
</table>

|   | 35/47 | 8/32 | $p = 0.00$ |
early menarche did differ significantly by group ($\chi^2(3) = 12.48$, $p = 0.01$) with no participants in the NT group experiencing early menarche, 18% in the NT:AS group, 17% in the AS group and 63% in the AS:AS group (Table 3). Those experiencing late menarche did not differ significantly by group ($\chi^2(3) = 1.25$, $p = 0.74$), though a reversal from the early menarche trend across groups can be seen with 8% having a late menarche in the NT group, 9% in the NT:AS group, 13% in the AS group and none in the AS:AS group. Taken together, these results suggest that females with ASD from multiplex families may be at increased risk for early AAM compared to those from simplex families and those with no family history of ASD.

**Figure 1.** Age at Menarche By Group.

![Reported Age at Menarche in Years by Group](image)

*The thick line indicates the median, the box represents the interquartile range, the whiskers indicate the range.

**Table 3.** Participants Reporting Early and Late Menarche

<table>
<thead>
<tr>
<th></th>
<th>NT (n = 12)</th>
<th>NT:AS (n = 35)</th>
<th>AS (n = 24)</th>
<th>AS:AS (n = 8)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Menarche</td>
<td>0%</td>
<td>18%</td>
<td>17%</td>
<td>63%</td>
<td>$\chi^2(3) = 12.48$</td>
</tr>
<tr>
<td></td>
<td>0/12</td>
<td>6/34</td>
<td>4/23</td>
<td>5/8</td>
<td>$p = 0.01$</td>
</tr>
<tr>
<td>Late Menarche</td>
<td>8%</td>
<td>9%</td>
<td>13.0%</td>
<td>0%</td>
<td>$\chi^2(3) = 1.25$</td>
</tr>
<tr>
<td></td>
<td>1/12</td>
<td>3/34</td>
<td>3/23</td>
<td>0/8</td>
<td>$p = 0.74$</td>
</tr>
</tbody>
</table>
Age at Menarche: Regression with Covariates

To control for factors known to be associated with AAM, pairwise correlations of AAM and covariates were conducted; Table 4 shows that of the variables collected, parent education and sibling with ASD were significant predictors of early AAM. These variables, along with the critical theoretical variables of group (AS v NT), race (White v Other), ethnicity (Non-Hispanic v Hispanic v Other), maternal AAM, and daughter’s BMI, were included in a multiple regression model to understand the impact of an ASD diagnosis in the family on AAM. The total model accounted for 30.83% of the variance in AAM and was found to be significant \((F(11, 54) = 2.19, p = 0.03)\). A diagnosis of an ASD in either the participant or a sibling significantly predicted younger AAM in the study participants \((\beta = -0.38, p > 0.01; \beta = -0.39, p > 0.01\), respectively), whereas mother’s AAM and daughter’s BMI showed moderate significance in predicting older AAM \((\beta = 0.23, p > 0.06; \beta = 0.23, p > 0.06\), respectively); the remaining variables were non-significant.

Table 4. Correlation Matrix of Covariates

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
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<tbody>
<tr>
<td>AAM</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>-0.10</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Race</td>
<td>0.01</td>
<td>-0.23*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Ethnicity</td>
<td>-0.11</td>
<td>0.01</td>
<td>0.03</td>
<td>1.00</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>BMI</td>
<td>0.07</td>
<td>0.14</td>
<td>-0.003</td>
<td>0.09</td>
<td>1.00</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ASD Sibling</td>
<td>-0.23*</td>
<td>-0.49*</td>
<td>-0.02</td>
<td>-0.00</td>
<td>0.03</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Mother AAM</td>
<td>0.08</td>
<td>0.20</td>
<td>-0.03</td>
<td>0.05</td>
<td>-0.13</td>
<td>0.01</td>
<td>1.00</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Mother AAP</td>
<td>-0.11</td>
<td>0.20</td>
<td>0.13</td>
<td>0.18</td>
<td>0.04</td>
<td>-0.27*</td>
<td>-0.01</td>
<td>1.00</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Pregnancy</td>
<td>0.11</td>
<td>-0.06</td>
<td>0.01</td>
<td>0.04</td>
<td>0.14</td>
<td>0.06</td>
<td>-0.12</td>
<td>-0.02</td>
<td>1.00</td>
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<tr>
<td>Weight Gain</td>
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</tr>
<tr>
<td>Preeclampsia</td>
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<td>0.01</td>
<td>-0.06</td>
<td>-0.19</td>
<td>0.36*</td>
<td>0.01</td>
<td>-0.21</td>
<td>-0.14</td>
<td>0.05</td>
<td>1.00</td>
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</tr>
<tr>
<td>Parent Education</td>
<td>0.25*</td>
<td>0.01</td>
<td>0.28</td>
<td>-0.03</td>
<td>-0.15</td>
<td>-0.17</td>
<td>0.07</td>
<td>0.44</td>
<td>0.14</td>
<td>-0.28*</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>Premature Birth</td>
<td>-0.07</td>
<td>0.07</td>
<td>-0.07</td>
<td>-0.09</td>
<td>0.02</td>
<td>0.15</td>
<td>-0.11</td>
<td>0.05</td>
<td>0.02</td>
<td>0.28*</td>
<td>0.01</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>-0.04</td>
<td>0.003</td>
<td>-0.01</td>
<td>-0.06</td>
<td>-0.18</td>
<td>-0.18</td>
<td>0.20</td>
<td>0.42*</td>
<td>0.04</td>
<td>-0.23*</td>
<td>0.46**</td>
<td>0.04</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* \(p < .05; \)** \(p < .01\)
Characteristics of the Menstrual Cycle

There were no significant differences in cycle length between groups, with the vast majority of cycles lasting 20 to 40 days; one AS participant reported a cycle length of 60 days. Period length lasted between three and nine days for all participants ($F(3,74) = 2.10, p = 0.11$), with post-hoc analyses revealing moderately shorter period length for AS:AS ($M = 5.38$, $SD = 1.51$ days) compared to AS ($M = 7.20$, $SD = 1.71$ days; $p = 0.10$). No difference between groups was observed in the number of participants reporting having regular periods (NT = 83%, NT:AS = 80%, AS = 78%, AS:AS = 100%). Heaviness of menstruation was also moderately significant, with AS:AS participants reporting moderately significant heavier flow than NT participants. No difference was observed between groups in presence of clots in menstrual flow, though a full three quarters of AS:AS participants reported clots compared to half or less across the other groups.

Nearly 90% of participants reported some level of pain with menstruation, with most of those reporting Mild to Moderate pain (87%); participants reporting ‘Severe’ pain were represented evenly across all groups (NT = 2, NT:AS = 4, AS = 2, AS:AS = 1). Groups reported no significant differences in pain related to the menstrual cycle ($F(3,74) = 0.94, p = 0.43$) or use of OTC pain medication ($\chi^2(3) = 5.62, p = 0.47$); however, effectiveness of pain medication was strongly significant ($F(3,43) = 4.66, p = 0.01$), with AS:AS reporting medication being the most effective at relieving pain symptoms ($M = 9.5$, $SD = 0.84$) compared to AS ($M = 5.46$, $SD = 3.26$; $p = 0.01$) and NT:AS ($M = 7.45$, $SD = 1.84$; $p = 0.34$) and NT ($M = 7.0$, $SD = 2.0$; $p = 0.38$) groups. AS to NT:AS was
also moderately different for medication effectiveness ($p = 0.10$). Of the participants reporting use of OTC pain medication for menstrual pain, 8% reported use of Naproxen, 70% Ibuprofen, and 22% Other pain medication. There were no differences in choice of pain medication across groups ($\chi^2(9) = 10.58, p = 0.31$). Hormonal birth control (HBC) use was seen only in the NT:AS (11%) and AS (12%) groups. Participants reporting HBC use to regulate their period (75%), to cause their periods to happen less frequently (25%), to decrease their menstrual symptoms (13%), and for ‘Other’ reasons (25%).

**Symptoms of the Menstrual Cycle**

80% of NT participants reported at least one premenstrual symptom compared to 54% of NT:AS, 58% of AS and 38% of AS:AS participants ($\chi^2(3) = 4.75, p = 0.19$). 75% of NT participants reported at least one symptom of dysmenorrhea, compared to 51% NT:AS 67% of AS and 75% of AS:AS ($\chi^2(3) = 3.32, p = 0.35$). 93% of NT participants reported experiencing at least one physical menstrual symptom, compared to 63% of NT:AS, 63% of AS and 88% of AS:AS ($\chi^2(3) = 5.30, p = 0.15$). For behavioral menstrual symptoms, 50% of NT participants reported experiencing at least one symptom, 43% of NT:AS, 42% of AS and 50% of AS:AS ($\chi^2(3) = 0.36, p = 0.95$). For emotional menstrual symptoms, 50% of NT participants reported experience at least one symptom, compared to 49% of NT:AS, 46% of AS and 63% of AS:AS ($\chi^2(3) = 0.68, p = 0.88$). No differences were observed between groups for premenstrual symptoms for both Count and Summary scores ($F(3,74) = 0.30, p = 0.82$; $\chi^2(9) = 17.66, p = 0.570$). A nearly significant difference was found between groups for Physical Menstrual Symptoms on the Count score ($F(3,74) = 2.61, p = 0.06$), with post-hoc Bonferroni tests showing the AS:AS group reporting
significantly more symptoms than their AS counterparts \( (p = 0.05) \) and moderately more than their NT:AS peers \( (p = 0.10) \). Significant differences were not found for the Count and Summary scores for Behavioral Menstrual Symptoms \( (F(3,74) = 1.23, p = 0.30; \chi^2(9) = 12.14, p = 0.21) \), Emotional Menstrual Symptoms \( (F(3,74) = 1.95, p = 0.13; \chi^2(9) = 10.17, p = 0.34) \), or Dysmenorrhea Symptoms \( (F(3,74) = 1.19, p = 0.32; \chi^2(9) = 9.48, p = 0.39) \). Results of Summary Scores are depicted in Figures 3. The top five most reported symptoms were pelvic pain: cramping at the time of a period \( (N = 44) \), change in mood at the time of a period \( (N = 28) \), change in mood just before a period \( (N = 27) \), bloating at the time of a period \( (N = 24) \), and a tie between irritability at the time of a period and change in appetite at the time of a period \( (N = 23) \). No differences were observed across groups for these symptoms (Table 5).

**Figure 2.** Burden of Menstrual Symptoms by Group

![Figure 2. Burden of Menstrual Symptoms by Group](image)
Table 5. Top Menstrual Symptoms by Group.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>NT</th>
<th>NT:AS</th>
<th>AS</th>
<th>AS:AS</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvic Pain:</td>
<td>67%</td>
<td>40%</td>
<td>54%</td>
<td>75%</td>
<td>$\chi^2(3) = 4.79$</td>
</tr>
<tr>
<td>Cramping</td>
<td>8/12</td>
<td>14/35</td>
<td>13/24</td>
<td>6/8</td>
<td>$p = 0.19$</td>
</tr>
<tr>
<td>Change in Mood:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During</td>
<td>30%</td>
<td>40%</td>
<td>25%</td>
<td>50%</td>
<td>$\chi^2(3) = 2.34$</td>
</tr>
<tr>
<td>Change in Mood:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before</td>
<td>50%</td>
<td>26%</td>
<td>33%</td>
<td>38%</td>
<td>$\chi^2(3) = 2.23$</td>
</tr>
<tr>
<td>Bloating</td>
<td>33%</td>
<td>34%</td>
<td>17%</td>
<td>38%</td>
<td>$\chi^2(3) = 2.27$</td>
</tr>
<tr>
<td>Irritability</td>
<td>40%</td>
<td>29%</td>
<td>13%</td>
<td>50%</td>
<td>$\chi^2(3) = 5.57$</td>
</tr>
<tr>
<td>Change in Appetite</td>
<td>23%</td>
<td>25%</td>
<td>21%</td>
<td>38%</td>
<td>$\chi^2(3) = 2.18$</td>
</tr>
</tbody>
</table>

**Lifestyle Interference**

There were significant differences in the frequency of missing school due to the
menstrual cycle ($\chi^2(3) = 17.54, p = 0.04$), most participants reporting missing school only with some periods (NT = 42%, NT:AS = 11%, AS = 13%, 13%), and only one participant in the AS:AS group who missed school with every period. No difference between groups was observed for number of school days missed ($F(3,9) = 1.70, p = 0.24$), with most participants missing fewer than two days per cycle. One participant in the AS:AS group reported missing up to 5 days of school per cycle because of her period. The rationale provided for missing school varied by group ($\chi^2(9) = 18.35, p = 0.03$). All participants the NT group reported missing school due to pain, whereas the NT:AS group reported pain (67%), heavy blood flow (8%) and ‘other’ reasons (25%), the AS group reported pain (25%), heavy blood flow (25%) and ‘other’ reasons (50%), and the AS:AS group reported nausea or vomiting (50%) and ‘other’ reasons (50%).

Participants reported little interference of the menstrual cycles with activities of daily life and there were no differences between groups on attending school ($F(3,71) = 0.25, p = 0.86$), completing school work ($F(3,72) = 1.00, p = 0.40$), social activities ($F(3,71) = 1.16, p = 0.33$), relationships with family ($F(3,72) = 0.26, p = 0.88$), or relationships with friends ($F(3,70) = 1.01, p = 0.39$). However, there was a significant difference in menstrual cycle interference on sports ($F(3,69) = 3.72, p = 0.02$), with participants in the NT group (M = 5.27, SD = 3.04) reporting significantly more interference than NT:AS group (M = 2.77, SD = 2.52; $p = 0.03$), the AS group (M = 2.3, SD = 2.18; $p = 0.01$). Results compared to the AS:AS group were non-significant (M = 3.0, SD = 2.0, $p = 0.37$). Similarly, no differences were observed between groups in interference on daily living by symptom. No differences between groups were observed
for pain ($F(3,67) = 1.92, p = 0.13$), heavy blood flow ($F(3,69) = 0.02, p = 1.00$),
tiredness or fatigue ($F(3,69) = 1.17, p = 0.33$), or moods ($F(3,69) = 1.70, p = 0.18$). A
moderate difference between groups was seen for interference of ‘generally feeling
unwell’ ($F(3,69) = 2.43, p = 0.07$), with participants in the NT group reported slightly
greater interference ($M = 6.33, SD = 3.14$) compared to the other groups (NT:AS: $M = 3.84, SD = 3.11, p = 0.13$; AS: $M = 4.32, SD = 3.39, p = 0.46$; AS:AS: $M = 2.86, SD = 1.86; p = 0.13$). Figures 4 and 5 show interference scores by group.

**Figure 3.** Lifestyle Interference by Activity.
Knowledge and Family History

A series of Chi-square analysis were run on Section 7 questions assessing participant’s knowledge and family history of several common gynecologic disorders. Few participants from any group reported having knowledge of PCOS, endometriosis and pelvic inflammatory disease; knowledge of these conditions was not significantly different across groups (See Table 6 for findings). Given their low familiarity, it was not surprising that participants reported very low incidence of these conditions in themselves, their mother or their sisters (Table 7 for findings).
Table 6. Knowledge of Gynecologic Disorders.

<table>
<thead>
<tr>
<th></th>
<th>NT</th>
<th>NT:AS</th>
<th>AS</th>
<th>AS:AS</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCOS</td>
<td>8%</td>
<td>14%</td>
<td>17%</td>
<td>0%</td>
<td>( \chi^2(6) = 6.41 )</td>
</tr>
<tr>
<td></td>
<td>1/12</td>
<td>5/35</td>
<td>4/23</td>
<td>0/8</td>
<td>( p = 0.38 )</td>
</tr>
<tr>
<td>Endometriosis</td>
<td>8%</td>
<td>6%</td>
<td>13%</td>
<td>25%</td>
<td>( \chi^2(6) = 5.45 )</td>
</tr>
<tr>
<td></td>
<td>1/12</td>
<td>2/35</td>
<td>3/23</td>
<td>2/8</td>
<td>( p = 0.49 )</td>
</tr>
<tr>
<td>Pelvic</td>
<td>33%</td>
<td>23%</td>
<td>17%</td>
<td>25%</td>
<td>( \chi^2(6) = 5.80 )</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>4/12</td>
<td>8/35</td>
<td>4/23</td>
<td>2/8</td>
<td>( p = 0.45 )</td>
</tr>
<tr>
<td>Disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Family History of Gynecologic Disorders.

<table>
<thead>
<tr>
<th></th>
<th>NT</th>
<th>NT:AS</th>
<th>AS</th>
<th>AS:AS</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period Problems</td>
<td>17%</td>
<td>29%</td>
<td>30%</td>
<td>50%</td>
<td>( \chi^2(6) = 5.25 )</td>
</tr>
<tr>
<td></td>
<td>2/12</td>
<td>10/35</td>
<td>7/23</td>
<td>4/8</td>
<td>( p = 0.52 )</td>
</tr>
<tr>
<td>Severe Period</td>
<td>17%</td>
<td>29%</td>
<td>17%</td>
<td>50%</td>
<td>( \chi^2(6) = 8.05 )</td>
</tr>
<tr>
<td>Pain</td>
<td>2/12</td>
<td>10/35</td>
<td>4/23</td>
<td>4/8</td>
<td>( p = 0.24 )</td>
</tr>
<tr>
<td>Pelvic</td>
<td>8%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>( \chi^2(6) = 11.12 )</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>1/12</td>
<td>0/35</td>
<td>0/23</td>
<td>0/8</td>
<td>( p = 0.09 )</td>
</tr>
<tr>
<td>Disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCOS</td>
<td>8%</td>
<td>13%</td>
<td>17%</td>
<td>13%</td>
<td>( \chi^2(6) = 7.40 )</td>
</tr>
<tr>
<td></td>
<td>1/12</td>
<td>1/35</td>
<td>4/23</td>
<td>1/8</td>
<td>( p = 0.29 )</td>
</tr>
<tr>
<td>Endometriosis</td>
<td>8%</td>
<td>0%</td>
<td>4%</td>
<td>25%</td>
<td>( \chi^2(6) = 12.25 )</td>
</tr>
<tr>
<td></td>
<td>1/12</td>
<td>0/35</td>
<td>1/23</td>
<td>2/8</td>
<td>( p = 0.06 )</td>
</tr>
<tr>
<td>Fibrocystic</td>
<td>11%</td>
<td>0%</td>
<td>4%</td>
<td>13%</td>
<td>( \chi^2(6) = 6.35 )</td>
</tr>
<tr>
<td>Breasts</td>
<td>1/9</td>
<td>0/35</td>
<td>1/23</td>
<td>1/8</td>
<td>( p = 0.39 )</td>
</tr>
</tbody>
</table>

Discussion

This study reveals an association between a diagnosis of ASD, in either participants or a sibling, and early age at menarche, with females from multiplex families reporting the earliest AAM. This finding supports earlier findings of a decrease in AAM in females with ASD (Burke et al., 2010), and stands in contrast to earlier publications reporting later AAM in the ASD population and those with high Autism-like traits (Hergüner & Hergüner, 2016; Knickmeyer et al., 2006; Whitehouse et al., 2011). Though these studies were conducted outside of the United States (England and Turkey), they were in countries similar in population structure and economic development to the US.
and report similar AAM. Of note, neither of these studies took BMI of the participant into account. Early age at menarche has been associated with increased BMI (Anderson, Dallal, & Must, 2003; Morrison et al., 1994), while decreased BMI has been associated with late menarche (Anderson et al., 2003). BMI is crucial to account for, especially considering reports of increased BMI in children and adolescents with ASD (Curtin, Jojic, & Bandini, 2014; Egan, Dreyer, Odar, Beckwith, & Garrison, 2013; Phillips et al., 2014). Earlier studies reporting later age at menarche in females with ASD have tied findings to the Androgen Theory of ASD, which posits that heightened prenatal exposure to testosterone may play a role in the development of ASD. The result of this study however suggests the possibility of an underlying developmental mechanism common to both ASD and AAM, such that with increased genetic loading the risk for both ASD and early AAM increase. As genetics play a clear role in both the development of ASD (Geschwind, 2011; Miles, 2011) and AAM (57-82% of the variance in AAM stems from genetic factors; Dvornyk & Waqar-ul-Haq, 2012), it is plausible that genes conveying increased risk for either or both ASD and AAM may cluster together.

This study is the first to characterize in detail the menstrual cycle of females diagnosed with ASD compared to NT peers. Participants in this study largely reported menstrual cycle characteristics similar to adolescents in the United States at large. According to the American College of Obstetricians and Gynecologists (ACOG Committee on Adolescent Health Care, 2006) normal cycle length for ranges from 20 to 45 days in the early menstrual years, settling to 21 to 34 days by the third menstrual year; both NT and AS participants reported cycles within this range. Period length is typically
3 to 7 days (ACOG Committee on Adolescent Health Care, 2006; Adams Hillard, 2008); only the AS group reported experiencing a cycle outside of these bounds (7.2 days), which was moderately longer than flow length reported in the other groups. As cycles are typically regular by the third menstrual year (ACOG Committee on Adolescent Health Care, 2006; Adams Hillard, 2008) and participants were on average 2.3 years post-menarche, it was unsurprising that the majority of participants across all groups reported having regular cycles. This provides an interesting contrast to reports of increased irregularity among women with ASD (Ingudomnukul et al., 2007; Pohl et al., 2014). Given the lack of a definition for ‘irregular cycle’ in both Ingudomnukul and Pohl’s studies and the older age of their participants, it is possible participants perceived their cycles as irregular without meeting traditional criteria (less than 21 days or greater than 45 days between menstruation; ACOG Committee on Adolescent Health Care, 2006) or that cycles for females with ASD may shift from a regular pattern in adolescence to an irregular pattern in early adulthood. The majority of participants reported having moderately heavy periods with the presence of clots, with no significant differences observed across groups. In contrast to previous findings, females with ASD in this study reported no difference in level of pain related to their menstrual cycle compared to peers. As previous studies have observed pain hyper- and hyposensitivity and differential pain expression in individuals with ASD (Allely, 2013; Courtemanche, Black, & Reese, 2016; Moore, 2015; Yasuda et al., 2016), it may be that females with ASD have more pain related to their period, but have difficulties interpreting or reporting the pain as such. Despite reporting less pain, multiplex and simplex participants reported elevated rates of
OTC pain medication use for menstrual-related pain. This may support the hypothesis that these individuals experience as much or possibly more menstrual pain than their typical peers but have difficulties in communicating or quantifying the pain, or alternatively, that their typical counterparts may select other remedies to menstrual pain, such as exercise or heat packs, over medication. Females from simplex and multiplex families (NT:AS, AS and AS:AS) were less likely to report experiencing pre-menstrual symptoms and physical menstrual symptoms than NT peers, and reported symptoms of dysmenorrhea, emotional and behavioral menstrual symptoms at similar rates. This may be driven by challenges in interpreting and reporting sensory input, unfamiliarity with terms used (at least one participant noted at the end of the questionnaires that she did not know what ‘Bloating’ meant and had asked her mother at the end of the study), or a true difference in menstrual experience.

Menstrual symptoms interfered significantly enough for participants from all groups to report missing school due to their menstrual cycle with some regularity, participants from the AS:AS group reported missing the most days of school due to their menstrual cycle. Interestingly, participants from the NT group reported more interference of the menstrual cycle across all activities (attending school, completing school work, participating in social activities, or relationships with friends and family), and significantly greater interference with sports compared to the other groups. Similarly, NT participants rated most menstrual symptoms (pain, tiredness, moods and feeling unwell) as more interfering with their life than participants from the other groups. Of note, participants from simplex families (NT:AS and AS groups) reported very similar
menstrual symptoms, and interference of the menstrual cycle across activities and symptoms. Knowledge of three common gynecologic disorders was low across all groups, and unsurprisingly, report of family history of these disorders was similarly low. However, significantly more participants in the AS:AS group reported a family history of endometriosis (25%) compared to the other groups (0%-8.3%), which is also elevated in comparison to general prevalence statistics (2-22% of otherwise asymptomatic women; Farquhar, 2000).

Together, these findings raise concern for the health of women with ASD. Earlier AAM is associated with increased BMI and abdominal type obesity, insulin insensitivity and Type 2 Diabetes, cardiovascular risk and coronary heart disease, breast cancer, and fertility impairment, as well as anxiety and depression in adolescence. Given the prevalence of obesity and poor nutrition in individuals with ASD (Curtin et al., 2014; Egan et al., 2013; Kral et al., 2015; Phillips et al., 2014), it is critical that practitioners serving this population carefully monitor for these negative health outcomes.

The main strengths of the current study are the use of self-report of AAM and menstrual symptoms, control of covariates known to be associated with AAM, as well as comparison to a Neurotypical group. In using self-report of both AAM and characteristics and symptoms of the menstrual cycle, these data provide a more accurate representation of menses as perceived by individuals themselves. While it may be possible that females with ASD are less perceptive of pain or menstrual symptoms due to differences in sensory perception, the criteria for participation in the study, specifically no diagnoses of Intellectual Disability and reading at a 4th grade lever or higher, suggests that these
findings accurately reflect the experience of menses for young women with ASD.

In evaluating the results of this study, it is important to consider some key limitations. First, while it the largest sample of females with ASD self-reporting AAM, our small sample size reached 77% power for the one-way ANOVA comparing our four groups on AAM. Further, our participants were predominately non-Hispanic White, from well educated, middle and upper income families. While this does strengthen our findings in regards to AAM, as race, ethnicity, and income have all been shown to be associated with AAM, this does limit the application of findings beyond these groups. Recruiting primarily through autism-focused research centers resulted in an ‘atypical’ control group, with the vast majority of participants reporting having a sibling diagnosed with an ASD. Though this impacted the ability to compare to a “true” Neurotypical group, it also resulted in the parsing of the NT group that led to our primary findings.

In summary, this study has observed a significant decrease in AAM in study participants with ASD and those with a sibling with ASD after adjusting for known covariates, including race, ethnicity, BMI, maternal AAM and parental education. These findings suggest a common developmental mechanism to ASD and AAM, resulting in earlier AAM with increased genetic loading.

Acknowledgements

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particularly grateful to all the families who participated, who gave so generously of their time and their stories to make this study a reality.
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StataCorp. (2015). *Stata statistical software: Release 14*. College Station, TX: StataCorp LP.


MANUSCRIPT 2.

Abstract

Study Objective: The objective of the study was to compare self- and parent- report on the onset and symptoms of the menstrual cycle in Autism Spectrum and Neurotypical populations. Due to the irregular nature of the early menstrual years, we sought to determine whether parents were accurate reporters of their daughter’s menstrual cycles, and whether parent report may be suitable for use in populations that are unable to self-report.

Design: Self- and parent-report on a modified version of the Menstrual Disorders of Teenagers (MDOT) Questionnaire and Screen for Childhood Related Anxiety Disorders (SCARED).

Setting: Web-based.

Participants: Females under the age of 18, with and without a diagnosis of Autism Spectrum Disorder (ASD), who had experienced menarche and one menstrual cycle in the previous six months, and a parent.

Main Outcome Measures: Age at menarche (AAM), characteristics and symptoms of the menstrual cycle.

Results and Conclusion: Parents of both Autism Spectrum Disorder and Neurotypical participants reported similar AAM and characteristics of the menstrual cycle as their daughters. Compared to daughters, Neurotypical parents underreported the severity and occurrence of their daughter’s menstrual symptoms across all reported areas, whereas parents of ASD adolescents did not follow this trend. ASD parents underreported level of menstrual pain, while reporting greater use of over-the-counter pain medication and greater efficacy of the medication in treating menstrual pain. ASD parents also reported more pre-menstrual, emotional and dysmenorrhea symptoms and fewer physical and behavioral menstrual symptoms than their daughters.

Keywords: Menarche, menstrual symptoms, self-report, parent-report, Autism Spectrum Disorder
**Introduction**

Menarche and menses are key components of every woman’s life, denoting reproductive capacity and the transition from child to woman in many cultures (Koff & Rierdan, 1993; Posner, 2006). Menarche is often used as the primary measure in research on puberty for females (Coleman & Coleman, 2002); although it is the last marker of the progression through puberty to adulthood, the sudden onset of menses contrasts to the gradual physical changes of puberty, such as breast or pubic hair growth, which are considered more difficult to recall or report (Brooks-Gunn, Warren, Rosso, & Gargiulo, 1987; Carskadon & Acebo, 1993; Coleman & Coleman, 2002). Moreover, self-report of age at menarche (AAM) is believed to be moderately reliable across the lifespan (Brooks-Gunn et al., 1987; Cooper et al., 2006; Dorn, Sontag-Padilla, Pabst, Tissot, & Susman, 2013; Koo & Rohan, 1997; Must et al., 2002). In the United States, menarche typically occurs between 12 and 13 years of age for non-Hispanic White females, with non-Hispanic Black females and Hispanic-American females typically experiencing menarche earlier (Chumlea et al., 2003). Race and ethnicity are two known factors that have been associated with AAM; Body mass index (BMI; Lassek & Gaulin, 2007; Morrison et al., 1994; Rosenfield, Lipton, & Drum, 2009), nutritional imbalances (Berkey et al., 2000), mother’s AAM (Graber, Brooks-Gunn, & Warren, 1995), as well as perinatal factors, such as preeclampsia (Vatten et al., 2003), maternal tobacco use during pregnancy (Windham, Bottomley, Birner, & Fenster, 2004) and small size at birth (Adair, 2001; Lazar, Pollak, Kalter-Leibovici, Pertzelan, & Phillip, 2003) have also been associated with AAM (Karapanou & Papadimitriou, 2010). In turn, AAM has been associated with
many serious health concerns across the lifespan, from breast cancer to obesity (Collaborative Group on Hormonal Factors in Breast Cancer, 2012; Freedman et al., 2003; Petridou et al., 1996), and insulin resistance to osteoporosis (Chevalley et al., 2009; Feng et al., 2008; Ho & Kung, 2005). Moreover, the symptoms of the menstrual cycle can significantly impact a woman’s quality of life throughout her menstrual years (Halbreich, Borenstein, Pearlstein, & Kahn, 2003; Hylan et al., 1999; Robinson & Swindle, 2000). Cumulatively, presentation of menses has substantial influence on a woman’s health and well-being throughout her life.

Understanding AAM and the presentation of menses is a critical component of every woman’s health, particularly so for women with developmental disabilities, such as Autism Spectrum Disorder (ASD). ASD, a pervasive neurodevelopmental disorder, is characterized by impairments in language and social communication, restricted interests, and repetitive behaviors (American Psychiatric Association, 2013). Accounts that females with disabilities do not receive routine gynecologic care are not uncommon (Burke et al., 2010; Coyle & Santiago, 2002; Iezzoni, McCarthy, Davis, & Siebens, 2000), yet the impairments characteristic of ASD, such as rigidity with schedules, difficulties with communication, and sensory differences, may pose unique challenges for women with the disorder as they navigate puberty. Sensory differences may complicate selecting or using feminine hygiene products, irregular menstrual cycles may conflict with the desire for routine and sameness, and more significantly impaired individuals may have difficulties communicating menstrual symptoms to others in such a way that they are accurately and appropriately treated. As we seek to better understand the life
course trajectory of this population and serve their needs as practitioners at all points of care, acknowledging and addressing gynecologic health as essential to their overall health is paramount.

Only a handful of studies have undertaken this issue to date and have reported mixed findings for AAM and menstrual symptom presentation. Reports of AAM have ranged from 11.7 years (Hamilton et al., 2011) to 13.3 years (Knickmeyer et al., 2006), with two studies observing an increase in AAM in Neurotypical (NT) females with high ‘autism-like’ traits (Hergün & Hergün, 2016; Whitehouse et al., 2011). Elevated rates of both precocious puberty (Pohl et al., 2014) and primary amenorrhea or delayed puberty (Ingudomnukul et al., 2007; Knickmeyer et al., 2006) have been observed in women with diagnoses of an ASD. Regarding menstrual symptoms, there is some evidence that they may be more likely to experience irregular cycles (Ingudomnukul et al., 2007; Pohl et al., 2014), dysmenorrhea (Ingudomnukul et al., 2007; Pohl et al., 2014), menorrhagia (Burke et al., 2010; Ingudomnukul et al., 2007), and premenstrual syndrome (Burke et al., 2010; Hamilton et al., 2011; Ingudomnukul et al., 2007; Pohl et al., 2014). The majority of these studies relied on parental report (Hamilton et al., 2011), chart review (Burke et al., 2010), retrospective report from adults (Ingudomnukul et al., 2007; Knickmeyer et al., 2006; Pohl et al., 2014), or proxy populations (Hergün & Hergün, 2016; Whitehouse et al., 2011) to characterize menses for women with ASD, or lacked a Neurotypical control group (Burke et al., 2010; Hamilton et al., 2011). While a crucial first step towards understanding the presentation of puberty and gynecologic health in this population, the data collected omits the voices of the individuals themselves and
adolescents in the midst of puberty. The experience of the menstrual cycle is one that is extremely subjective and personal, one that females with a diagnosis of ASD may have challenges in reporting or conveying the nuisances of to others. Thus, this study sought to understand the similarities or differences in self- and parent-report of AAM and the menstrual cycle.

Methods

Facing Puberty Study Procedure

This study reports the findings from the parent and daughter dyads participating in the cross-sectional, descriptive Quantitative Phase of the Facing Puberty Study. The Facing Puberty Study was explanatory sequential mixed-methods study addressing the onset, presentation and experience of menses for females with Autism Spectrum Disorder compared to Neurotypical (NT) peers through web-based questionnaires and semi-structure dyad interviews. Eligible for participation were females (1) with and without diagnoses of an ASD, (2) under the age of 18 years, (3) who had begun menstruating, with (4) at least one menstrual cycle within six months of participating, as well as one of their parents. Please refer to Manuscript 1 for complete details of study procedure.

Area of Exploration

The following areas were assessed through the web-based questionnaires for analysis.

Demographics. The demographic questionnaire assessed participants’ age, race and ethnicity, height and weight for BMI calculation, primary language and education; parents were additionally asked their marital status, family income, daughter’s age at and
ASD diagnosis, daughter’s use of prescription and non-prescription medication, diagnosis of an ASD in other family members, their own AAM, and weight gain, presence of preeclampsia or prematurity during their pregnancy with their daughter.

**Age at Menarche.** For both parents and daughter, age at menarche was calculated from the midpoint of the reported month and year that daughter began menstruating and the daughter’s date of birth (e.g., [Menarche (1/15/16) – DOB (10/8/00)]/365.25 = 15.3 years at menarche). Menarche was classified as Early Menarche if the reported age was less than or equal to 11 years and Late Menarche if the reported age at menarche was greater than or equal to 14 years; these ages are commonly used for reporting early and late menarche (Freedman et al., 2003; Gaudineau et al., 2010; Ho & Kung, 2005; Johansson & Ritzen, 2005; Varraso et al., 2005). In the United States, less than 10% of females begin menstruating before age 11 and more than 90% have begun by age 14 (Chumlea et al., 2003).

**Characteristics and Symptoms of the Menstrual Cycle.** The modified Menstrual Disorders of Teenagers Questionnaire (MDOT; Parker et al., 2010) assessed typical menstrual cycle characteristics such as cycle length, period length, and regularity, as well as menstrual symptoms, interference of the menstrual cycle with activities of daily life, beliefs about their menstrual cycle, and a brief assessment of knowledge and family history with gynecologic disorders. Modifications made from the original version included changing wording to that more commonly used in the United States, changing pain medication to those more commonly used in the United States, inclusion of more menstrual symptoms for a fuller account of symptoms experienced by participants, as
well as omission of questions surrounding sexual practice, relationships, and identity, as they were not pertinent to the study’s goals. While the MDOT has not yet been validated or with the ASD population, it was selected and used with the corresponding author’s permission for its depth and breadth of assessment of the menstrual cycle for teenagers (Parker, 2014).

Cycle length, defined as the first day of one period to the first day of the next (typically 20 to 45 days in adolescent females; Adams Hillard, 2008), and period length, defined as the number of menstrual days (typically 3-7 days; Adams Hillard, 2008), as well as regularity of cycle and presence of clots were assessed. Participants rated their level of menstrual pain on a scale from 0 to 10, with scores of 1-3 indicating ‘Mild’ pain, 4-7 ‘Moderate’ pain, and 8-10 ‘Severe’ pain, as well as use of over-the-counter (OTC) pain medication and its effectiveness. Participants reported presence of menstrual symptoms by ‘No or Never’, ‘Just before a period’, ‘At the time of my period’, ‘Any time of the month’, ‘All the time’ or ‘Sometimes’. Count scores for Pre-Menstrual Symptoms, Physical Menstrual Symptoms, Behavioral Menstrual Symptoms, Emotional Menstrual Symptoms and Dysmenorrhea were created from responses to symptoms experienced in relation to the participant’s monthly cycle in Section 3 (see Table 1). Count scores reflect the total number of symptoms reported by the participant at the appropriate time (i.e., ‘Just before a period’ for Pre-Menstrual Symptoms and ‘At the time of my period’ for menstrual symptoms). Further, the top six menstrual symptoms reported by daughters are explored. The top six menstrual symptoms identified by daughters were: (1) pelvic pain: cramping at the time of a period, (2) changes in mood at the time of a period, (3) changes
in mood just before a period, (4) bloating at the time of a period, and a tie for (5) with feeling irritable at the time of a period and (6) changes in appetite at the time of a period.

**Anxiety.** To compare reporting of a subjective experience across parents and daughters, the Screen for Childhood Related Anxiety Disorders (SCARED; Birmaher et al., 1997; Birmaher et al., 1999) was included to assess presence of anxiety symptoms in the participants. This anxiety measure has been used extensively in the ASD population and has demonstrated reliable results between self- and parent-report (Stern, Gadgil, Blakeley-Smith, Reaven, & Hepburn, 2014).

**Table 1. Symptoms of the Menstrual Cycles**

<table>
<thead>
<tr>
<th>Pre-Menstrual Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
</tr>
<tr>
<td>Bloating</td>
</tr>
<tr>
<td>Constipation</td>
</tr>
<tr>
<td>Diarrhea</td>
</tr>
<tr>
<td>Headaches</td>
</tr>
<tr>
<td>Indigestion</td>
</tr>
<tr>
<td>Breast Tenderness</td>
</tr>
<tr>
<td>Acne</td>
</tr>
<tr>
<td>Changes in sleep</td>
</tr>
<tr>
<td>Changes in appetite</td>
</tr>
<tr>
<td>Lower back pain</td>
</tr>
<tr>
<td>Feeling down or depressed</td>
</tr>
<tr>
<td>Difficulties concentrating</td>
</tr>
<tr>
<td>Irritability</td>
</tr>
<tr>
<td>Anxiety related to the period</td>
</tr>
<tr>
<td>Changes in mood</td>
</tr>
<tr>
<td>Tearfulness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Menstrual Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea</td>
</tr>
<tr>
<td>Vomiting</td>
</tr>
<tr>
<td>Bloating</td>
</tr>
<tr>
<td>Diarrhea</td>
</tr>
<tr>
<td>Constipation</td>
</tr>
<tr>
<td>Indigestion</td>
</tr>
<tr>
<td>Pelvic pain</td>
</tr>
<tr>
<td>Lower back pain</td>
</tr>
<tr>
<td>Aching outside the vagina or down the legs</td>
</tr>
<tr>
<td>Thrush</td>
</tr>
<tr>
<td>Headache</td>
</tr>
<tr>
<td>Dizziness</td>
</tr>
<tr>
<td>Breast pain or tenderness</td>
</tr>
<tr>
<td>Acne</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Behavioral Menstrual Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in sleep</td>
</tr>
<tr>
<td>Changes in Appetite</td>
</tr>
<tr>
<td>Feeling withdrawn or decreased social interest</td>
</tr>
<tr>
<td>Difficulties concentrating</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Emotional Menstrual Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling down or depressed</td>
</tr>
<tr>
<td>Irritability</td>
</tr>
<tr>
<td>Anxiety related to the period</td>
</tr>
<tr>
<td>Changes in mood</td>
</tr>
<tr>
<td>Tearfulness or feeling weepy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dysmenorrhea Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aching – outside the vagina</td>
</tr>
<tr>
<td>Aching – down the legs</td>
</tr>
<tr>
<td>Pelvic pain: aching</td>
</tr>
<tr>
<td>Pelvic pain: cramping</td>
</tr>
<tr>
<td>Pelvic pain: stabbing</td>
</tr>
<tr>
<td>Pelvic pain: other</td>
</tr>
<tr>
<td>Lower back pain</td>
</tr>
</tbody>
</table>
Analyses

Participants were divided into four groups for analysis: daughters with ASD (ASD) and their parents (ASP), Neurotypical daughters (NTD) and their parents (NTP). Demographic characteristics were assessed using independent sample t-tests to compare age and BMI for parents and daughters separately. All other demographic variables were assessed using chi-square tests across all four groups. Paired t-tests and chi-square tests were conducted to compare self- and parent-report of AAM, menstrual cycle characteristics, menstrual symptoms and interference. Independent t-tests were used to compare the difference in report between parent and daughters across groups. It is important to note that no questions in the web-based questionnaires required an answer from the participant, and thus the numbers of dyads differ across analyses. There were no patterns found between missing values and group. For all tests, a $p$-value of $< 0.05$ was considered significant and a $p$-value of 0.05-0.10 was considered moderately significant. Following analysis of AAM, only significant findings are reported in text. Please refer to tables for other results.

Results

Participants

The majority of parent participants were mothers (ASP = 97%, NTP = 98%). Parents were moderately different in age, with ASP participants being slightly older at participation ($M = 45.17, SD = 6.03$ years) than NTP participants ($M = 43.01, SD = 5.87; p = 0.11$). Dyads were predominately non-Hispanic White, however more NTD participants described themselves as ‘Other/Two or More’ Races than in the other groups.
(NTD = 31%, NTP = 19%, ASD = 12%, ASP = 12%; p = 0.08). Significantly more NTD participants described themselves as ‘Hispanic’ (15%) or ‘Other’ (17%) than participants in the other groups (p = 0.05). BMI was similar for ASD (M = 23.13, SD = 4.55) and NTD participants (M = 21.92, SD = 4.73; p = 0.21), and for ASP (M = 29.60, SD = 9.83) and NTP participants (M = 27.55, SD = 5.80; p = 0.25). The majority of participants spoke English as a first language, parents were well educated (65% of AS parents had a Bachelor’s Degree or higher, as did 60% of NT parents) and reported middle to high income. Table 2 shows the demographic characteristics of participants.

Though all participants diagnosed with an ASD are considered as one group for the purpose of this study, ASP were asked to report their daughter’s ASD diagnosis and age at diagnosis to understand potential variations in key variables by the previous diagnostic categories of Autism, Asperger’s Syndrome, Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS), as well as the new label of ASD. Parents reported diagnoses of Autism (35%), PDD-NOS (18%), Asperger’s Syndrome (29%), and ASD (18%). ASP reported daughters diagnosed with PDD-NOS receiving the diagnoses earliest (M = 41.33, SD = 18.9 months), followed by Autism (M = 60.58, SD = 56.5 months), Asperger’s Syndrome (M = 69.1, SD = 26.3 months), and ASD (M = 98.0, SD = 45.0 months). The increased age at diagnosis for ASD may be due to the change in diagnostic criteria away from Autism, PDD-NOS and Asperger’s Syndrome to a unified Autism Spectrum Disorder that occurred in 2013 with the publication of the 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders. Thus the differences in age at diagnosis across these groups should be interpreted with caution (see Table 3).
Table 2. Participant Demographics.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14.59 ± 1.94 years</td>
<td>43.01 ± 5.87 years</td>
<td>14.45 ± 1.88 years</td>
<td>45.17 ± 6.03 years</td>
<td>Daughters: t(80) = -0.31, p = 0.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Parents: t(79) = 1.62, p = 0.11</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \chi^2(3) = 6.83, p = 0.08 )</td>
</tr>
<tr>
<td>White</td>
<td>33</td>
<td>39</td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Other / Two</td>
<td>15</td>
<td>9</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \chi^2(6) = 12.43, p = 0.05 )</td>
</tr>
<tr>
<td>Hispanic</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>33</td>
<td>40</td>
<td>29</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>21.92 ± 4.73</td>
<td>27.55 ± 5.80</td>
<td>23.125 ± 4.55</td>
<td>29.60 ± 9.83</td>
<td>Daughters: t(78) = 1.26, p = 0.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Parents: t(75) = 1.15, p = 0.25</td>
</tr>
<tr>
<td>Language</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \chi^2(5) = 6.16, p = 0.41 )</td>
</tr>
<tr>
<td>English</td>
<td>46</td>
<td>44</td>
<td>34</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Spanish</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Parent Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \chi^2(4) = 2.01, p = 0.74 )</td>
</tr>
<tr>
<td>HS/GED - College</td>
<td>12</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Associate’s</td>
<td>6</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Bachelor’s</td>
<td>13</td>
<td>13</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Master’s</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Professional/Doctoral</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( \chi^2(5) = 8.79, p = 0.12 )</td>
</tr>
<tr>
<td>Less than $20,000</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$20-60,000</td>
<td>8</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$60-100,000</td>
<td>21</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$100-150,000</td>
<td>10</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than $150,000</td>
<td>7</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Autism Spectrum Disorder Related Characteristics of AS and NT Groups

<table>
<thead>
<tr>
<th>ASD Dx</th>
<th>NT (n = 48)</th>
<th>AS (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>48</td>
<td>0</td>
<td>----</td>
</tr>
<tr>
<td>Autism</td>
<td>0</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>PDD-NOS</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Asperger’s</td>
<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>ASD</td>
<td>0</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Age at Diagnosis</td>
<td></td>
<td></td>
<td>F(3,64) = 4.10</td>
</tr>
<tr>
<td>Autism</td>
<td>60.58 ± 56.5 months</td>
<td></td>
<td>p = 0.01</td>
</tr>
<tr>
<td>PDD-NOS</td>
<td>41.33 ± 18.9 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asperger’s</td>
<td>69.1 ± 26.3 months</td>
<td></td>
<td>PDD-ASD: p = 0.01</td>
</tr>
<tr>
<td>ASD</td>
<td>98.0 ± 45.0 months</td>
<td></td>
<td>Autism-ASD: p = 0.07</td>
</tr>
<tr>
<td>ASD Sibling</td>
<td>74%</td>
<td>25%</td>
<td>( \chi^2(1) = 18.78, p = 0.00 )</td>
</tr>
<tr>
<td></td>
<td>35/47</td>
<td>8/32</td>
<td></td>
</tr>
</tbody>
</table>
AAM and Menstrual Cycle Characteristics

**Neurotypical.** NT parents and daughters reported overwhelmingly similar AAM and characteristics of the menstrual cycle. There was no difference in AAM between parent and daughter report (t(43) = -0.01, p = 0.99; Figure 1). Further, there were no differences between NTP and NTD in reported AAM that met criteria for Early Menarche ($\chi^2(1) = 0.10, p = 0.75$) or Late Menarche ($\chi^2(1) = 1.00, p = 1.00$; Figure 2). NTP reported slightly, non-significantly shorter cycle length and moderately shorter period length compared to NTD, underestimating on average by half a day (Table 4). A similar proportion of NTP and NTD reported daughters as having regular cycles with moderately heavy menstrual flow; fewer parents reported the presence of clots for their daughter, though this difference was non-significant (Table 4).

**Autism Spectrum.** ASP reported slightly earlier AAM compared to ASD (Figure 1), though this difference was non-significant (t(32) = 0.84, p = 0.41). A similar proportion of ASD and ASP participants reported AAM that met criteria for Early Menarche ($\chi^2(1) = 0.04, p = 0.85$) and Late Menarche ($\chi^2(1) = 0.13, p = 0.72$; Figure 2). ASP reported shorter cycle length and significantly shorter period length compared to ASD, underestimating period length by an average of 0.65 days (Table 4). A similar proportion of ASD and ASP participants reported the daughters’ cycle as being regular with moderately heavy flow, though fewer ASP reported presence of clots compared to ASD (Table 4).
Figure 1. Age at Menarche by Group

*The thick line indicates the median, the box represents the interquartile range, the whiskers indicate the range.

Figure 2. Proportion of Reported Age at Menarche Meeting Criteria for Early, Typical, and Late Menarche by Group.
Table 4. Characteristics of the Menstrual Cycle by Group

<table>
<thead>
<tr>
<th></th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>Significance</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cycle Length</strong></td>
<td>30.64 ± 8.61 days</td>
<td>30.32 ± 8.58 days</td>
<td>t(24) = 0.68, p = 0.50</td>
<td>29.4 ± 9.15 days</td>
<td>27.46 ± 2.79 days</td>
<td>t(14) = 0.91, p = 0.38</td>
</tr>
<tr>
<td><strong>Period Length</strong></td>
<td>6.68 ± 1.99 days</td>
<td>6.15 ± 1.62 days</td>
<td>t(40) = 1.90, p = 0.06*</td>
<td>6.78 ± 1.83 days</td>
<td>6.13 ± 1.41 days</td>
<td>t(29) = 2.72, p = 0.01**</td>
</tr>
<tr>
<td><strong>Regular Cycle</strong></td>
<td>79.1%</td>
<td>75.0%</td>
<td>χ²(1) = 0.20</td>
<td>81.8%</td>
<td>83.3%</td>
<td>χ²(1) = 0.03</td>
</tr>
<tr>
<td><strong>Flow Quality</strong></td>
<td>2.74 ± 0.57</td>
<td>2.63 ± 0.83</td>
<td>t(40) = 0.82, p = 0.42</td>
<td>2.99 ± 0.76</td>
<td>3.02 ± 0.76</td>
<td>t(28) = -0.19, p = 0.85</td>
</tr>
<tr>
<td>(Scale: 1-5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Clots (% Yes)</strong></td>
<td>52%</td>
<td>39%</td>
<td>χ²(1) = 1.61</td>
<td>52%</td>
<td>46%</td>
<td>χ²(1) = 0.16</td>
</tr>
<tr>
<td></td>
<td>25/48</td>
<td>15/39</td>
<td>p = 0.21</td>
<td>17/33</td>
<td>13/28</td>
<td>p = 0.69</td>
</tr>
</tbody>
</table>

**Menstrual Symptoms**

**Neurotypical.** Compared to NTD, NTP followed a pattern of underreporting menstrual symptoms, including the level of pain their daughters experienced, the use of OTC pain medication to treat menstrual pain, and the level of effectiveness of OTC pain medication (Table 5), although none of these differences were significant. NTP also underreported the number of symptoms experienced across all symptom categories (Table 6), though this trend was only significant for number of behavioral menstrual symptoms experienced. For the top menstrual symptoms, the proportion of NTP reporting the presence of pelvic pain: cramping was identical to NTD. Fewer NTP reported changes in mood at the time of a period, and more NTP reported changes in mood just before a period. Also, fewer NTP reported bloating, irritability, and significantly fewer NTP reported changes in appetite compared to NTD (NTD = 29%, NTP = 10%; χ²(1) = 5.32, p = 0.02; Figure 3).

**Autism Spectrum.** Compared to ASD, ASP reported that their daughters experienced less pain related to their menstrual cycle, reported more use of OTC pain medication for treating menstrual pain, and that the OTC pain medication was more
effective at treating pain (Table 5). Further, ASP reported that their daughters experienced significantly more pre-menstrual symptoms ($t(33) = -2.72$, $p = 0.01$), and marginally more symptoms of dysmenorrhea and emotional menstrual symptoms (Table 6). In contrast, ASP reported that their daughters had fewer physical menstrual symptoms ($t(33) = 1.84$, $p = 0.07$) and behavioral menstrual symptoms ($t(33) = 1.82$, $p = 0.08$; Table 6). An identical proportion of ASP reported presence of pelvic pain: cramping as ASD and more ASP reported presence of change in mood at the time of a period and just before a period, and irritability. In contrast, fewer ASP reported presence of bloating or changes in appetite than ASD (Figure 3).

**Table 5. Pain Characteristics of the Menstrual Cycle by Group**

<table>
<thead>
<tr>
<th></th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>Significance</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain (Scale: 0-10)</td>
<td>4.38 ± 2.63</td>
<td>3.95 ± 2.47</td>
<td>$t(38) = 1.51$</td>
<td>4.57 ± 2.67</td>
<td>4.21 ± 2.35</td>
<td>$t(27) = 0.70$</td>
</tr>
<tr>
<td></td>
<td>p = 0.14</td>
<td>p = 0.14</td>
<td>$p = 0.49$</td>
<td>p = 0.01</td>
<td>p = 0.07</td>
<td>$p = 0.13$</td>
</tr>
<tr>
<td>Pain Medication Use</td>
<td>48%</td>
<td>43%</td>
<td>$\chi^2(2) = 3.31$</td>
<td>50%</td>
<td>67%</td>
<td>$\chi^2(2) = 4.10$</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>$p = 0.19$</td>
<td>$p = 0.19$</td>
<td>$p = 0.66$</td>
<td>$p = 0.01$</td>
<td>$p = 0.08$</td>
<td>$p = 0.50$</td>
</tr>
<tr>
<td></td>
<td>7.05 ± 2.48</td>
<td>7.0 ± 2.53</td>
<td>$t(21) = 0.06$</td>
<td>7.59 ± 2.40</td>
<td>7.82 ± 2.13</td>
<td>$t(16) = -0.44$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.95$</td>
<td>$p = 0.95$</td>
<td>$p = 0.66$</td>
<td>$p = 0.07$</td>
<td>$p = 0.50$</td>
<td>$p = 0.62$</td>
</tr>
</tbody>
</table>

**Table 6. Menstrual Symptom Count Variables by Group**

<table>
<thead>
<tr>
<th></th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>Significance</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Menstrual Symptoms (0-17)</td>
<td>2.60 ± 3.29</td>
<td>2.52 ± 2.95</td>
<td>$t(47) = 0.13$</td>
<td>2.26 ± 3.03</td>
<td>3.74 ± 3.22</td>
<td>$t(33) = -2.72$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.90$</td>
<td>$p = 0.90$</td>
<td>$p = 0.01$</td>
<td>$p = 0.43$</td>
<td>$p = 0.07$</td>
<td>$p = 0.08$</td>
</tr>
<tr>
<td>Dysmenorrhea (0-7)</td>
<td>1.56 ± 1.83</td>
<td>1.15 ± 1.37</td>
<td>$t(47) = 1.31$</td>
<td>1.38 ± 1.50</td>
<td>1.59 ± 1.69</td>
<td>$t(33) = -0.79$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.20$</td>
<td>$p = 0.17$</td>
<td>$p = 0.43$</td>
<td>$p = 0.07$</td>
<td>$p = 0.50$</td>
<td>$p = 0.62$</td>
</tr>
<tr>
<td>Physical Menstrual Symptoms (0-14)</td>
<td>2.65 ± 2.47</td>
<td>1.94 ± 2.15</td>
<td>$t(47) = 1.40$</td>
<td>2.82 ± 2.32</td>
<td>2.15 ± 2.13</td>
<td>$t(33) = 1.84$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.17$</td>
<td>$p = 0.17$</td>
<td>$p = 0.07$</td>
<td>$p = 0.08$</td>
<td>$p = 0.50$</td>
<td>$p = 0.62$</td>
</tr>
<tr>
<td>Behavioral Menstrual Symptoms (0-4)</td>
<td>0.75 ± 0.93</td>
<td>0.38 ± 0.67</td>
<td>$t(47) = 2.28$</td>
<td>0.76 ± 1.16</td>
<td>0.44 ± 0.95</td>
<td>$t(33) = 1.82$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.03$</td>
<td>$p = 0.03$</td>
<td>$p = 0.08$</td>
<td>$p = 0.08$</td>
<td>$p = 0.50$</td>
<td>$p = 0.62$</td>
</tr>
<tr>
<td>Emotional Menstrual Symptoms (0-5)</td>
<td>1.06 ± 1.33</td>
<td>0.77 ± 1.29</td>
<td>$t(47) = 1.04$</td>
<td>1.32 ± 1.74</td>
<td>1.44 ± 1.80</td>
<td>$t(33) = -0.50$</td>
</tr>
<tr>
<td></td>
<td>$p = 0.30$</td>
<td>$p = 0.30$</td>
<td>$p = 0.50$</td>
<td>$p = 0.50$</td>
<td>$p = 0.62$</td>
<td>$p = 0.62$</td>
</tr>
</tbody>
</table>
Figure 3. Most Frequently Reported Menstrual Symptoms by Group

Interference

Neurotypical. NTP reported similar frequency and duration of missing school due to menses as NTD, though most NTD attributed missing school due to menstrual pain, whereas NTP attributed it to heavy blood flow and nausea/vomiting (Table 7). Parents reported less interference for completing school work, social activities, and significantly less interference with sports ($t(45) = 2.01, p = 0.05$), and more interference for attending school, relationships with family and relationships with friends than NTD (Figure 4). Further, NTP reported pain and generally feeling unwell as interfering significantly less with their daughters activities of daily life than NTD (Pain: NTD $M = 4.96$, $SD = 3.08$, NTP $M = 3.93$, $SD = 2.95$; $t(40) = 2.44, p = 0.02$; Unwell: NTD $M = 4.71$, $SD = 3.26$, NTP $M = 3.21$, $SD = 2.71$; $t(41)= 2.82, p = 0.01$), and rated heavy blood flow, tiredness and moods as less interfering than their daughters did, though these
differences were non-significant (Figure 5).

**Autism Spectrum.** ASP and ASD reported similar frequency and duration of missing school due to menses; while ASD attributed missing school to a variety of reasons (Pain, Heavy Blood Flow, Nausea/Vomiting and Other reason near equally), most ASP reported Pain or Heavy Blood Flow as the main cause (Table 7). ASP reported more interference of the menstrual cycle than ASD across all activities, with significantly more interference for completing school work ($t(29) = -1.95, p = 0.06$), social activities ($t(29) = -2.11, p = 0.04$) and sports ($t(28) = -2.34, p = 0.03$; Figure 5). Further, ASP reported all symptoms except for pain as interfering more with their daughters’ lifestyle than ASD, with Mood as significantly more interfering ($t(28) = -2.19, p = 0.04$; Figure 6).

**Table 7. Menstrual Interference with School by Group**

<table>
<thead>
<tr>
<th>Missing School</th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>Significance</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>38</td>
<td>37</td>
<td>$\chi^2(1) = 0.03$</td>
<td>27</td>
<td>27</td>
<td>$\chi^2(1) = 1.39$</td>
</tr>
<tr>
<td>Yes, every</td>
<td>1</td>
<td>1</td>
<td>$p = 0.99$</td>
<td>1</td>
<td>1</td>
<td>$p = 0.71$</td>
</tr>
<tr>
<td>Yes, some</td>
<td>9</td>
<td>8</td>
<td></td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

| Days Missed (days)    | 1.33 ± 0.52  | 1.5 ± 0.45   | $t(5) = -1.58$ | 2.33 ± 2.31  | 1.67 ± 1.15  | $t(2) = 1.00$ |
|                       |              |              | $p = 0.17$     |              |              | $p = 0.42$ |

<table>
<thead>
<tr>
<th>Rationale</th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>Significance</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>9</td>
<td>6</td>
<td>$\chi^2(2) = 1.89$</td>
<td>1</td>
<td>3</td>
<td>$\chi^2(3) = 1.37$</td>
</tr>
<tr>
<td>Heavy Blood Flow</td>
<td>1</td>
<td>2</td>
<td>$p = 0.39$</td>
<td>1</td>
<td>2</td>
<td>$p = 0.71$</td>
</tr>
<tr>
<td>Nausea/Vomiting</td>
<td>0</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Figure 4. Menstrual Interference by Group

Figure 5. Interference by Symptom by Group

Anxiety

Neurotypical. NTP reported significantly lower summary scores on the SCARED
than NTD ($t(47) = 3.99, p = 0.00$). Across all sub-scales, NTP had significantly lower scores than NTD (Table 8).

**Autism Spectrum.** In contrast to NT group, there was strong agreement between ASD and ASP groups for SCARED scores. There were no differences between AS parents and daughters on the summary score or any of the sub-scales (Table 8).

**Table 8. SCARED Scores by Group**

<table>
<thead>
<tr>
<th></th>
<th>NTD (n = 48)</th>
<th>NTP (n = 48)</th>
<th>Significance</th>
<th>ASD (n = 34)</th>
<th>ASP (n = 34)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary Score</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score</td>
<td>24.73 ± 17.20</td>
<td>15.75 ± 14.60</td>
<td>$t(47) = 3.99$, $p = 0.00^*$</td>
<td>28.34 ± 15.19</td>
<td>26.28 ± 17.78</td>
<td>$t(31) = 0.82$, $p = 0.42$</td>
</tr>
<tr>
<td><strong>Panic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.29 ± 5.42</td>
<td>2.52 ± 4.05</td>
<td>$t(47) = 3.72$, $p = 0.00^*$</td>
<td>5.81 ± 4.99</td>
<td>4.91 ± 5.72</td>
<td>$t(31) = 1.95$, $p = 0.30$</td>
</tr>
<tr>
<td><strong>Generalized Anxiety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.52 ± 5.40</td>
<td>5.19 ± 4.93</td>
<td>$t(47) = 3.24$, $p = 0.00^*$</td>
<td>8.22 ± 5.27</td>
<td>7.91 ± 5.30</td>
<td>$t(31) = 0.47$, $p = 0.64$</td>
</tr>
<tr>
<td><strong>Separation Anxiety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.33 ± 2.96</td>
<td>1.77 ± 2.37</td>
<td>$t(47) = 3.77$, $p = 0.00^*$</td>
<td>4.49 ± 3.14</td>
<td>4.28 ± 4.30</td>
<td>$t(31) = 0.27$, $p = 0.79$</td>
</tr>
<tr>
<td><strong>Social Anxiety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.23 ± 4.49</td>
<td>4.63 ± 4.35</td>
<td>$t(47) = 2.46$, $p = 0.02^*$</td>
<td>7.63 ± 4.44</td>
<td>7.09 ± 4.34</td>
<td>$t(31) = 0.69$, $p = 0.49$</td>
</tr>
<tr>
<td><strong>School Avoidance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.35 ± 2.07</td>
<td>1.65 ± 1.67</td>
<td>$t(47) = 2.73$, $p = 0.01^*$</td>
<td>2.22 ± 1.93</td>
<td>2.09 ± 1.89</td>
<td>$t(31) = 0.40$, $p = 0.69$</td>
</tr>
</tbody>
</table>

**Discussion**

Parents from both Neurotypical and Autism Spectrum populations in our study proved to be accurate and reliable reporters of daughters’ AAM when compared to daughters’ self-report. While there were no significant differences observed in AAM between NT and AS groups, participants with ASD reported slightly earlier AAM, experiencing menarche approximately four months earlier than their NT peers. Of note, significantly more AS parents and daughters reported AAM that met criteria for Early Menarche compared to NT parents and daughters; however there were no differences in those meeting criteria for Late Menarche. As menarche is such a significant life event for
adolescent females, it is not surprising that they choose to disclose the event to their parents and that it is remembered accurately by both parties. This study establishes that parents are accurate reporters of their adolescent daughters’ AAM.

Daughters from both AS and NT groups reported characteristics of the menstrual cycle within the normal range for adolescents, with cycle lengths averaging 27.5 to 30.6 days (normal range for adolescents: 20-45 days; ACOG Committee on Adolescent Health Care, 2006; Adams Hillard, 2008), period lengths between 6 and 7 days (normal range for adolescents: 3-7 days; ACOG Committee on Adolescent Health Care, 2006; Adams Hillard, 2008) and moderately heavy menstrual flow with clots for the majority of participants. Parents of both AS and NT participants reported shortened cycle lengths for their daughters and significantly shorter period length, underestimating period length by approximately half a day. Parents of both groups were in agreement with their daughters on regularity of cycle and heaviness of flow, but underreported presence of clots. These findings may be due to the shared responsibility verses sole responsibility of managing menses. For the majority of adolescent females, some activities of managing menses, such as changing pads, are the sole responsibility of the daughters, which gives parents less opportunity to observe more nuanced details of the menstrual cycle, such as presence of clots. However, some activities, such as purchasing sanitary products, are shared responsibilities between the daughter and parent. Frequency and use of sanitary products is a good estimate not only of the length and regularity of the menstrual cycle (i.e., how often the daughter is requesting more sanitary products), but also the heaviness of flow (i.e., how many sanitary products the daughter uses per day or per cycle). This shared
versus sole responsibility of managing menses may contribute to the differences observed in parent- versus self-report of characteristics of the menstrual cycle.

In reporting menstrual symptoms, some interesting differences were observed between parent- and self-report across the AS and NT groups. While NTP underestimated menstrual symptoms in their daughters, from level of pain to number of symptoms across all symptom categories, ASP did not follow this same pattern in reporting on their daughters’ menstrual symptoms. Notably, ASP reported more OTC pain medication use and greater effectiveness in treating menstrual pain than their daughters did. They also reported that their daughters experienced more pre-menstrual symptoms, symptoms of dysmenorrhea and emotional menstrual symptoms than ASD self-reported. It may be that parents of daughters with Autism Spectrum Disorder are more attuned to their child’s use of medication, given the use of both OTC and prescription medication in the population (Aman, Lam, & Collier-Crespin, 2003). As individuals with ASD have demonstrated differences in perceiving and reporting pain (Allely, 2013; Moore, 2015; Yasuda et al., 2016), it is plausible that females with ASD have difficulties interpreting menstrual symptoms, such as cramping or bloating, as pain or discomfort to then report to their parents or self-report on a questionnaire. Parents may perceive shifts in mood or engagement and, knowing that their daughter is menstruating, attribute that change to menstrual pain or menstrual symptoms. This hypothesis may be further supported in considering AS to NT report for the top menstrual symptoms; more ASD reported the presence of cramping pelvic pain and change in mood just before a period than NTD, whereas fewer reported the presence of all other top menstrual symptoms. Cramping is
perhaps the most well-known and frequently discussed menstrual symptom among adolescents; females with ASD may be reporting presence of cramping in preference over other symptoms because it is (1) recognizable, (2) an accepted symptom of menses, and (3) because of sensory perception differences, they may have difficulties interpreting or translating the physical and sensory experience to lay or clinical terms.

In considering the impact of menses on the daughters’ activities of daily life, parents from both NT and AS groups broadly reported similar impact as their daughters, with a few key differences. NTP were accurate reporters of the frequency, length and rationale of missed school due to menses, whereas more ASP reported that their daughters missed school more frequently and for fewer days, and for different reasons than ASD reported. Parents from both groups reported more interference of menses in attending school, relationships with family and relationships with friends. AS parents reported more interference of menses across all activities and for all symptoms than their daughters, expect for level of interference due to menstrual pain, whereas NT parents reported less interference of menses across activities and symptoms. This may simply reflect ASP perceptions that their daughters’ menstrual cycle disrupts the normal life of daughter and the family, or perhaps that they observe a true increase in disruption surrounding the menstrual cycle than their daughters, who may have difficulties perceiving these changes due to the impairments of ASD.

In sharp contrast to the similarities observed between self- and parent-report on menses, NTP reported significantly lower scores on the SCARED than NTD on the summary score and across all sub-scales. No differences were observed between ASD
and ASP groups on the SCARED. While mean scores for NTP and NTD did not meet the cutoff score for presence of an anxiety disorder, NTD fell just shy of this mark, demonstrating an atypically high rate of anxiety for a Neurotypical control group. Nearly 48% of NTD met this cut off, compared to 53% of ASD. The prevalence of anxiety in the ASD population is commonly held to be approximately 40% (range 11-84%; White, Oswald, Ollendick, & Scahill, 2009), compared to 18% of the Neurotypical population (Kessler, Chiu, Demler, & Walters, 2005). Considering that nearly 75% of the NT group reported a diagnosis of ASD in a sibling of the daughter, it is likely that this group represents an “atypical” control group and may have greater risk of mood disorders.

This study is the first to compare self- to parent-report of AAM, characteristics and symptoms of the menstrual cycle across Neurotypical and ASD populations and is the first to utilize an adolescent sample from the ASD population. However, with the prevalence of intellectual disabilities approximately 40% (Christensen, 2016; Werling & Geschwind, 2013), adolescent females with a diagnosis of ASD who are able to participate in studies such as this one represent a narrow target population and it is unsurprising that the study faced difficulties in recruitment that led to the small sample size. Congruent findings may have been due to the clear topic of the study; while participants were asked to report from their own point of view and parents reminded not to confer with their daughter on responses, the study was clearly stated to be on menarche and menses, which may have triggered discussions between parent and daughter prior to participation that may have improved congruency in report. Further, given the discrepancy between parent and daughter report of anxiety symptoms for the NT group,
which was not highlighted as a main component of the study, discussion prior to participation is probable. Given that the experience of menarche was relatively recent (daughters were on average 2.3 years post-menarche), it is possible that parents are more familiar with their daughter’s cycle during these early menstrual years as they are more active in managing their daughter’s cycle, helping them to assume the responsibility of menstrual management, and adapting to their changing bodies. In a free response section at the end of the study, some AS parents reported assisting their daughter through the questionnaire and discovered that their daughters reported symptoms they had hitherto not been aware of, as well as learning that their daughters were unfamiliar with a number of common menstrual symptom terms, such as bloating. While this did provide an opportunity for the parents and daughters to discuss these points, it may also have impacted both the parents and daughters reporting of symptoms.

This study demonstrates that parents are accurate reporters of AAM, and moderately accurate reporters of the characteristics and symptoms of their daughters’ menstrual cycle. Further, these findings suggest that parents may be used as reliable proxy reporters for issues of gynecologic health of daughters who may be unable to self-report symptoms. While many of the findings reported here were non-significant, the trends observed between parent- and self-report in both NT and AS groups help to elucidate the highly individual and personal experience of menses that may not always lend itself well to report from one outside the experience. Finally, these results both strengthen and clarify previous findings on this subject that have utilized parent-report.
Acknowledgements

The authors would like to thank the University of Pennsylvania, School of Nursing Office of Nursing Research for their generous funding of this study, as well as the Center for Autism Research at the Children’s Hospital of Philadelphia and the Interactive Autism Network for their assistance in recruitment for this study. We are particularly grateful to all the families who participated, who gave so generously of their time and their stories to make this study a reality.
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MANUSCRIPT 3.

In Their Own Words: Exploring the Experience of Puberty for Girls with Autism

Spectrum Disorder
Abstract

Living with an Autism Spectrum Disorder (ASD) presents challenges across the lifespan. For young women, puberty is often a period of significant social, physical and emotional upheaval. This time can be particularly challenge for young women with ASD. Through semi-structured interviews of parent-participant dyads, we sought to understand the experiences of these young women as they navigate periods and puberty. Participants discussed several themes, including education and preparation for puberty, the physical experience of menses, speed bumps on the road through puberty, managing the everyday, and looking to the future. This study underscores the unique and varied experiences of puberty for females with ASD, and the importance of qualitative research in moving towards a holistic understanding of adolescence for these young women.

Keywords: Autism Spectrum Disorder, Females, Puberty, Menses, Qualitative, Semi-structured Interviews
Introduction

Background

Autism Spectrum Disorder (ASD) is a chronic neurodevelopmental disorder manifesting in early childhood that is characterized by impairments in social communication, restricted interests and repetitive behaviors (American Psychiatric Association, 2013). Though a substantial literature base on the disorder has been published since it was first described by Leo Kanner in 1943 (Kanner, 1943), the majority of research to date has focused on the presentation of the disorder, possible underlying etiology, the early childhood experience and interventions (Matson & LoVullo, 2009), leaving the life-course trajectory of those with ASD relatively poorly understood. For females, who represent approximately one fifth of those with ASD (Christensen, 2016), this deficit is compounded by omission and exclusion from research on the disorder due to historical belief that autism occurs only in males, their minority status in the autism community, and study design limitations (Shefcyk, 2015). This exclusion has had significant ramifications, from a poorer understanding of the manifestation of ASD in females (Halladay et al., 2015), to delayed diagnoses (Begeer et al., 2013), and lack of support and targeted intervention for females as they age (Shefcyk, 2015).

Research directed towards understanding puberty in females with ASD is in its infancy. A handful of studies over the past 10 years have begun to highlight differences in timing of menarche and presentation of women’s health issues, reporting increased rates of precocious puberty (Pohl et al., 2014), primary amenorrhea (Ingudomnukul et al., 2007; Knickmeyer et al., 2006), painful and irregular menstrual cycles (Ingudomnukul et
al., 2007; Pohl et al., 2014), as well as polycystic ovarian syndrome within this population (Ingudomnukul et al., 2007; Pohl et al., 2014). Yet the experience of puberty for these young women, what it’s like to live where these two phenomena meet, is strikingly absent from the literature. Only Cridland et al.’s exploration of the experiences of adolescence for females with ASD, notable as the only qualitative study in the field, briefly touched upon puberty and related issues (Cridland et al., 2014). Their study, drawing only from mothers of females with ASD, reached the conclusion that menarche and menses were largely unremarkable. While this study omitted the voices of the adolescents themselves on this issue, representations from those at the core of the issue, both parents and daughters, are crucial for reaching a more complete understanding of puberty in females with ASD.

Statement of the Problem

Puberty represents a significant life event for all human beings. The social, physical, and emotional changes of this period impact an individual’s health across the life span. In conjunction with the behavioral and interpersonal impairments associated with ASD, puberty and adolescence may present challenges to those on the Spectrum that are as diverse and challenging as the disorder itself. Little is understood about menses in this group and as a result there are few, if any, targeted interventions to support young women with ASD through this transition. Many important questions remain unanswered: What do they face as they progress through puberty? Who is there to support them? How do puberty and ASD interact to shape their experience of adolescence?

Purpose of the Study
A thorough understanding that accounts not only for the presentation of puberty, but also the experiences and needs of these women as they perceive them, is currently lacking, yet fundamental. In order for practitioners at all levels to provide safe, appropriate and accurate education and health care to these women, their voices must first be heard. The Autism community has been outspoken in recent years, calling for increased attention to the experiences of individuals with ASD across the lifespan (Bölte, 2014). Accordingly, this study, the *Facing Puberty Study*, sought to understand the phenomenon of puberty for females with ASD through a mixed-methods approach. The study team employed descriptive, web-based questionnaires and semi-structured qualitative interviews with daughter and parent dyads. The study sought to gain a deeper, grounded understanding of puberty and the early adolescent years for these young women and their families through their own voices and stories.

**Methods**

**Design and Approach**

This paper represents the Qualitative Phase of the Facing Puberty Study, an explanatory sequential mixed-methods study addressing the onset, presentation and experience of puberty for females with ASD and their families (see Chapter 1 for more detail). Eligible participants for the study were females with a diagnosis of Autism Spectrum Disorder (including Autistic Disorder, Pervasive Developmental Disorder- Not Otherwise Specified, and Asperger’s Syndrome), under the age of 18 years, who had begun menstruating, with at least one menstrual cycle in the previous six months, able to read English at a 4th grade level. Additionally, we interviewed one parent of each
participant who met the inclusion criteria. In this phase of the study, the principle
investigator interviewed parents and daughters about the daughters’ experience with
menses, puberty and adolescence. Parents’ experiences were sought in addition to their
daughters, as parents have unique perspective and insight into the issues of puberty, and
may have been able to provide clarification to illuminate their daughters’ experiences
through triangulation.

This study is rooted in the constructivist philosophy, which strives to understand
phenomena through participants and their subjective views (Creswell & Plano Clark,
2011). The experience of menses and puberty is one that is highly subjective, lending
itself to exploration through qualitative methods in this philosophy. Following in the
Constructivist philosophy, the qualitative descriptive approach of thematic analysis was
used to interpret and organize data from the semi-structured interviews (Braun & Clarke,
2006; Vaismoradi, Turunen, & Bondas, 2013). Thematic analysis is a flexible qualitative
tool, which provides a nuanced, thick and detailed account of the data across a set of
interviews (Braun & Clarke, 2006; Morgan & Zhao, 1993).

Data Collection

This study was approved by University of Pennsylvania’s Institutional Review
Board. Participants were recruited primarily through two Autism research databases,
autismMatch in Philadelphia, PA and the Interactive Autism Network (IAN) in Baltimore,
MD. A study summary was available on the autismMatch website with a link to the study
website. IAN emailed eligible families within their registry with the study summary and
website to notify them of the opportunity. Interested participants visited the study website
to review aims and consent (parent) or assent (daughter) to participate as appropriate.

While both participants with ASD and Neurotypical control participants completed the online questionnaires that comprised the Quantitative Phase of the study, only those with ASD and their parents were eligible for selection to participate in the semi-structured interviews that comprised this study. After the Quantitative Phase of this study (discussed in Manuscripts 1 and 2) had reached 50% target recruitment, 15 parent-participant dyads were selected by the researcher and invited by email to schedule the interviews. Emails included a review of the interview structure and potential discussion topics. Of these, nine of the fifteen dyads responded to the email invitation and participated in the interview phase of the study. A second round of participants were selected and invited to participate, of these two dyads responded and one dyad participated, resulting in a final sample of 10 dyads or 20 participants (10 parents and 10 daughters). All interviews were conducted between May 11th and June 13th, 2016.

Interviews were conducted, in person (one dyad) over the phone (eight dyads) or via Skype (one dyad) based on participant preference and geographic access. Participants interviewed over phone and Skype were asked to find a quiet location for the interviews and to have a clear two hour window of time so they would not be disturbed or feel pressed for time during the interviews; the in-person interview was conducted at a quiet location of the participants choosing. Parents and daughters were interviewed individually, though allowed to be present and participate during one-another’s interviews. Some dyads used this alternative arrangement, with the parent present in the daughter’s interview to support, facilitate and clarify when necessary (four dyads), or the
daughter present in parent’s interview to gain a better understanding of the topics to be discussed and structure of the interview (three dyads). Interviews began with a word association exercise (“What things come to mind when you think about puberty/periods?”) allowing the participants to ‘warm-up’ before the semi-structured interview. Semi-structured interviews are designed to promote flexibility, allowing the researcher to follow the participant’s response and direction for maximization of valid, detailed data (Smith & Osborn, 2008). Prompts were available to stimulate dialogue, with clarifying questions asked by the researcher if necessary (Appendices J and K). Participants were encouraged to freely discuss their experiences with adolescence and puberty; no attempts were made to influence a participant’s answers. On average, interviews with dyads lasted for 45 minutes (range 36-70 minutes). Participants were given a $25 gift card as compensation. All interviews were recorded for transcription. The interview guides were informed by the literature and developed with input from mentors and experts in the field. Following guidelines for iterative refinement of the interview guide, early interviews were reviewed and the guide was adapted and supplemented as topics emerged from the first two completed interviews and the guide was reviewed again following the eighth interview, with no additions or modifications made at that time (Kvale & Brinkmann, 2009).

Data Analyses

All interviews were transcribed verbatim and uploaded to NVivo 11 (QSR International Pty Ltd, 2012), a software program used to manage qualitative data and facilitate analysis. Data collection and analysis were conducted simultaneously to allow
the researcher to determine the point of saturation (that is when no new information was being garnered from the interviews) in order to determine the need to recruit additional participants. Based on a review of the preliminary data analysis, the team determined that no more than ten parental-daughter dyads were needed (Crabtree & Miller, 1992; Glaser & Strauss, 2009). Detailed data analysis was subsequent to completion of data collection. The author conducted all interviews and transcribed the audio-recordings verbatim, furthering familiarization with the data.

As no studies have previously addressed the interaction of puberty and ASD in females through qualitative methods, an inductive approach to code book development was employed (MacQueen, McLellan, Kay, & Milstein, 1998). That is, the PI and mentor open coded a selection of transcripts (Braun & Clarke, 2006; Hsieh & Shannon, 2005). Each code was given an explicit definition to ensure coding accuracy and to improve intercoder reliability (Crabtree & Miller, 1992; Glaser & Strauss, 2009). Codes were then refined and cross-checked with the author’s expert committee until consensus regarding definitions was reached. Themes emerged from codes and were reviewed, defined, and named following Braun & Clark (2006) thematic analysis process.

**Preliminary Results**

**Participants**

Selected parent-participant dyads were drawn from the Quantitative Phase of the Facing Puberty Study. Participants were selected using purposive sampling to achieve a heterogeneous group on (1) age at menarche, (2) ASD diagnoses, (3) age, and (4) race and ethnicity. All parents participating were mothers, with the majority married (n = 9).
with Bachelor’s degrees or higher (n = 8). Daughters participating were between the ages of 13 and 16 years old, predominately Non-Hispanic White (n = 7), and in high school classroom setting (Typical Classroom = 5, Home Schooled = 2, Special Education = 2, Unknown = 1). Dyads were all located in the United States; the majority of parents reported an annual income of greater than $60,000. Please refer to Table 1 for more detailed information. Participants are referred to by numbered “parent” and “daughter” to protect privacy.

Table 1. Demographic Information of Participants

<table>
<thead>
<tr>
<th>Daughter (Age)</th>
<th>Ethnicity &amp; Race</th>
<th>ASD Diagnosis</th>
<th>Age at Diagnosis</th>
<th>Age at Menarche</th>
<th>Co-Morbidity</th>
<th>Sibling with ASD</th>
<th>Mother (Age)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daughter 1 (14)</td>
<td>Non-Hispanic White</td>
<td>PDD-NOS</td>
<td>2.67 years</td>
<td>11.85 years</td>
<td>Allergies, Anxiety, Asthma, Migraines</td>
<td>Unknown</td>
<td>Parent 1 (44)</td>
</tr>
<tr>
<td>Daughter 2 (15)</td>
<td>Hispanic, Asian</td>
<td>ASD</td>
<td>12 years</td>
<td>12.64 years</td>
<td>Allergies, Asthma</td>
<td>No</td>
<td>Parent 2 (45)</td>
</tr>
<tr>
<td>Daughter 3 (14)</td>
<td>Non-Hispanic Native American</td>
<td>Autistic Disorder</td>
<td>10 years</td>
<td>9.52 years</td>
<td>Allergies, Asthma, Migraines</td>
<td>Yes</td>
<td>Parent 3 (45)</td>
</tr>
<tr>
<td>Daughter 4 (16)</td>
<td>Non-Hispanic White</td>
<td>Asperger’s Syndrome</td>
<td>2.5 years</td>
<td>12.41 years</td>
<td>Anxiety, Depression</td>
<td>No</td>
<td>Parent 4 (50)</td>
</tr>
<tr>
<td>Daughter 5 (15)</td>
<td>Non-Hispanic White</td>
<td>Autistic Disorder</td>
<td>15 months</td>
<td>9.94 years</td>
<td>None</td>
<td>Yes</td>
<td>Parent 5 (51)</td>
</tr>
<tr>
<td>Daughter 6 (13)</td>
<td>Non-Hispanic Native American &amp; White</td>
<td>Asperger’s Syndrome</td>
<td>5 years</td>
<td>12.07 years</td>
<td>None</td>
<td>No</td>
<td>Parent 6 (51)</td>
</tr>
<tr>
<td>Daughter 7 (14)</td>
<td>Non-Hispanic White</td>
<td>Asperger’s Syndrome</td>
<td>6 years</td>
<td>12.95 years</td>
<td>Anxiety</td>
<td>No</td>
<td>Parent 7 (43)</td>
</tr>
<tr>
<td>Daughter 8 (16)</td>
<td>Non-Hispanic White</td>
<td>ASD</td>
<td>8 years</td>
<td>15.04 years</td>
<td>Anxiety</td>
<td>No</td>
<td>Parent 8 (46)</td>
</tr>
<tr>
<td>Daughter 9 (14)</td>
<td>Non-Hispanic White</td>
<td>PDD-NOS</td>
<td>4.5 years</td>
<td>13.6 years</td>
<td>None</td>
<td>No</td>
<td>Parent 9 (49)</td>
</tr>
<tr>
<td>Daughter 10 (16)</td>
<td>Non-Hispanic White</td>
<td>Asperger’s Syndrome</td>
<td>9.25 years</td>
<td>14.1 years</td>
<td>Anxiety, Depression</td>
<td>No</td>
<td>Parent 10 (43)</td>
</tr>
</tbody>
</table>

* ASD = Autism Spectrum Disorder, PDD-NOS = Pervasive Developmental Disorder-Not Otherwise Specified
Codes were organized into six thematic categories, 1) Preparations for Puberty, 2) Physical Experience of Menses, 3) Speed Bumps on the Road through Puberty, 4) Managing the Everyday, 5) Looking Forward, and 6) Reflective Advice. While the thematic labels do not necessarily correspond to exact phrases used by the participants, they were selected by the researchers to conceptualize and summarize the issues reflected within each theme. Participants’ thoughts and experiences were diverse across the themes identified and many of the themes had bridging elements to one another. This analysis seeks to review the highlights and key findings from this phase of the study. Summative statements for these themes are followed by supportive quotes. Quotes have been lightly edited for clarity and edits are noted by [brackets]. Responses from daughters are presented first, followed by parents, to showcase the distinct and at times conflicting experiences expressed by the parent and daughter.

Preparations for Puberty

Daughters shared a variety of experiences in getting ready for puberty and menarche, including learning about the changes that were to take place from their parents and at school.

“We did like a little separation thing [where] boys went with boys, and girls went with girls. And, I remember it was like 5th grade, something like that. And, [the teacher] was like ‘Oh, you have to use pads!’ and she showed us this video. Then in like 8th grade we were supposed to switch, so the boys went to girls and the girls went to the boys, but we didn’t do that. I was just a little bit wondering. I was wondering if boys had something like periods, or something like that.”

*Daughter 1 (14)*

“I learned it from my parents. I had like ‘The Talk’ when I was about six. We’re always very open, so I learned about, like, bodies and how they work normally. Er, not normally, but just sorta, when I asked a question, and there’d be no avoiding it. There’d be no ‘But uh… uhh… when you’re older’, no it just sorta happened. Sometimes during dinner, we’ll bring up like sex or something, there’s always
more to learn. Cause just when you think it’s over, there’s more. So that’s pretty much when we learn it, it just comes up in conversation.” Daughters explained that the onset of menarche was somewhat confusing or anxiety provoking and they reported being reassured by parents who provided information and support.

“So I was just in the bathroom and then I saw blood and I was like ‘Mom! Mom!’ and she was like ‘Okay, you just started your period’ and then she gave me a pad to put on and that was it.” Daughter 2 (15)

“I saw that there was brown stuff in my underwear and I [thought] I had like pooped myself, so I showed like my mom my underwear and she told me I got my period.” Daughter 4 (16)

“Well [I was] anxious, ‘Oh, what’s gonna happen to my body?’ When I first started my period, I felt like ‘Oh, what’s happening?’ and ‘Why is it there?’ And, and my mom talked to me about it and I understand what it means.” Daughter 5 (15)

Parents also shared how they helped their daughter get ready for puberty and menarche, drawing from a wide variety of resources and strategies. Some mothers took lead roles in opening the conversation with their daughters; others preferred to wait until someone or something else introduced the topic, for example a book or their daughter’s physician.

“When she started to develop, you know, primary sexual characteristics or whatever the word is, hair and breast buds and those things, I started talking to her about it, you know, so that she understood what was going on with her body. I don’t think any child should be in the dark about that stuff. But even more so a child on the Spectrum needs to know that.” Parent 1 (44)

“I think the thing that worked out best for us is a lot of education. We got our education through our pediatrician, who’s a female pediatrician. Knowing that kids with ASD respond differently to people who are not their parents, that was really helpful. She responded very well to the pediatrician giving her the ‘What to Expect’ [talk] versus an alternative, which is me sitting down with a book and pictures and trying to explain it. I think it comes off differently when it’s like someone outside that close relationship. Then after she had that discussion, we talked about it here and there. I actually let her ask me questions about it, rather
than me initiating it, and I think that also helps. I could see how it could be very scary though for both the mother and child, but for me I didn’t get that feeling just because I had a lot of support and I had a pediatrician that took the time to spend time and talk about that.” Parent 2 (45)

Some reported experiencing some resistance from their daughters, who appeared to not want to have to go through puberty or deal with menses.

“Well I just let her know, this is what’s going to happen, this is what you’re going to need to do and you know this is about the time frame it happens and I would tell her this is a normal thing, it happens to everybody and she was really resistant to the idea and she wouldn’t really say much, sometimes she would say ‘Oh that’s not going to happen to me’. I did bring it up a lot and talk to her a lot, just so even though she wouldn’t talk back to me about it, at least on some level of consciousness she did know this is going to happen, so it wasn’t a complete surprise to her.” Parent 10 (43)

“We talked about it and when we first started, it was funny, she told me that she didn’t want it. But we spent a lot of time with that book [The Care and Keeping of Me]. As much as she would. We had to do it in little doses because she would totally tune out.” Parent 9 (49)

Physical Experience of Menses

Both parents and daughters brought up the physical experience of menses often. Daughters expressed experiencing some pre-menstrual symptoms, particularly emotional changes and mood swings.

“[I get] like really emotional [before my period], I think. I think it’s a lot of emotions, mostly sad. Yeah, and irritable.” Daughter 4 (16)

“I don’t like always expect [my period’s] coming, but then I’m like oh yeah, that makes sense cause I’ll be weirdly emotional or something.” Daughter 10 (16)

“Just like I have a couple [days] before I get my period I’ll get like mood swings, but that’s kinda it.” Daughter 2 (15)

“A few weeks before, like two weeks before I get a little bit PMS-y. But during my period, I’m fine. [It’s] sadness and anger most of the time.” Daughter 6 (13)

In contrast, parents expressed more severe pre-menstrual symptoms that had substantial
impacts on their daughters.

“The hormones, the hormonal fluctuations, a week prior to her period were very challenging, in terms of anxiety specifically. Anxiety, moodiness, touchiness, all of that, seemed to be heightened. And that was, that’s on a very consistent basis. I mean like above and beyond typical PMS.” Parent 1 (44)

“When she’s kinda close to her period, and she’ll say ‘I don’t know why I’m crying! I don’t know what’s wrong!’ and then I’ll be able to say, ‘Do you think it’s because you’re close to your period now?’ and she’ll be ‘Oh, yeah!’ But it’s very overwhelming for her to try and deal with those emotions. A couple days prior she, she might be a little bit more, sorta snappy. Nothing that, you know, having gone through the teenaged stuff with now five [daughters], nothing that what her sisters are capable of doing or we’re capable of doing. But, you know, for her you can definitely kinda see that she’ll do that usually when she says something and she’s not sure that it’s acceptable, she’ll immediately say ‘I’m sorry if I was attitudinal’ and ‘I don’t mean to be attitudinal’. And so, that filter that she sets up to check and to kind see if she’s socially appropriate or not, kinda goes away when she’s getting close to her period and then, usually every month, maybe skipping a month here or there she just has an emotional crying break down, and just you know, something will just go, you know, she’ll see a yellow jacket and that will cause an absolute melt down of crying for 45 minutes. Just that irrational, emotional piece.” Parent 6 (51)

Other parents reported that their daughters experienced relatively minor or insignificant symptoms before menstruation.

“[She doesn’t] have a great deal of PMS symptoms to indicate when [she’s] about to have it, [she’s] very regular.” Parent 7 (43)

When reflecting on the symptoms associated with menses, daughters reported feeling more tired, having cramps and being a little bit more ‘on edge’ emotionally.

“[I feel] anxious. Sometimes I feel a little sluggish. Um, that’s it, sluggish. Um, well sometimes when you’re on your period you feel tired for some reason, and I guess when you’re on your period that just happens. Um, sometimes I feel like I have stomach cramps. It’s a little hurting, but it’s not like I’m like hurting a lot. Sometimes I feel dizzy in my head.” Daughter 5 (15)

“[The cramping’s] not always mild. It’s actually during the end of the period when most of the blood has stopped, and that’s when the cramping just comes. It’s weird. Sometimes I can be a little off, just but not really. Uh, I feel a bit more tired, although that could just be me. I don’t know. I feel less mobile, cause the
underwear I find very restricting and pad very restricting, which is kind of
annoying. I know that I don’t sleep as well, because you know I, I take melatonin
to get to bed, I’ve got insomnia issues, I don’t sleep very well, but when I wake
up, instead of drifting back to sleep, I know that I have to go and I have to change
my pad and by then I’m so awake I know I’m not going to get back to sleep for
another hour or so, so that could be why I’m more tired, I don’t know.” Daughter
7 (14)

“[…] I’m always tired. I sleep about the same at night and take naps during the
day as well, and it’s kind of emotions are much higher and [I feel] sore, tired. The
blood area, things that are tearing themselves apart. Sort of the emotions are much
higher, like one of those times I just end up crying and I’m like ‘What’s wrong?’
and I’m like ‘I don’t know, just like leave me alone for a while, it’ll get better.’ [I]
just end up crying for no particular reason, not even feeling like upset or anything,
just couldn’t stop crying. Now [it’s] not as often, it’s more like hey, I’m feeling
happy, and now I’m not feeling happy. Mood swings, I guess you would call it.”
Daughter 10 (16)

“It doesn’t really feel [like] anything, just like on the second day or third day I’ll
start getting cramps but like, that’s kinda it. I tend to get moody, just like I have a
couple days like before I get my period I’ll get like mood swings, but that’s kinda
it.” Daughter 2 (15)

Parents shared similar thoughts, telling stories of increased emotional sensitivity and
difficulties in expressing emotions.

“She can be a little moody. Sometimes it’s just like, you, you try to just tell her,
‘You need to go do this’ she could just freak out and start crying. And her daddy,
he could say boo to her and she’ll start crying.” Parent 5 (51)

“She’s definitely moodier. But, I do think, you know, it’s hard for them to explain
that.” Parent 9 (49)

“I think what’s the hardest piece for her is the emotional piece. I don’t know that
she can identify that that’s where it is, but that’s where she seems to be the most
uncomfortable. And the most unsure, I mean you add the hormones on to
whatever’s going on and all of us, it kind of [overwhelming]. But I think that’s
where she has the most trouble coping with her period is the emotional piece,
because she’s really, really good at keeping her emotions kind of in check, and I
think she feels kinda overwhelmed by them when she’s on her period. Just from
my outside view. I think in this area at least of her life, um, I think the biggest
issue for her is the hormones and the emotions make her uncomfortable. I think
she can handle the pain, and I think that she feels, that she hates how she feels,
with not being able to control her emotions the way she wants to. So, you know,
grain of salt there.” Parent 6 (51)

Others didn’t see substantial change in their daughter across the menstrual cycle.

“It’s just kind of surprising, because I thought she pretty much didn’t have symptoms, but then when we were filling out the questionnaires she was saying that she would feel symptoms, like she would start feeling, like she didn’t know what the word ‘bloated’ was, but she felt kinda yucky and sad, you know. She’s mentioned that she’d start feeling a little irritable and cranky and all that. So I didn’t see any of that, but she reported that she did. But as far as from a mother’s point of view um, I don’t see anything at all, I um, expect just her anxieties that it’s coming. She would really like me to be able to tell her it’s gonna start on Tuesday at 9am, that would be really, really great for [her]. I said it doesn’t work like that.” Parent 8 (46)

Parents also expressed their impressions of how their daughters experienced and communicated menstrual pain.

“For someone who has sort of extreme sensory issues with any kind of touch, it’s interesting her pain threshold is actually really high.” Parent 7 (43)

“[…] she does have a very high pain threshold. Yeah. I think she experiences less, but it’s hard to say how much of that is a communication [thing], you know, not telling me about it, versus not feeling the pain. Um, I think that the sensory, the pads, the feel of the pad bothers her more than the pain. So in that case, I mean I would say that her pain threshold is definitely higher than typical.” Parent 1 (44)

“As soon as she starts, I get a phone call from her school that she need pain meds. And it’ll even be, this last month she had started and I asked her if she wanted to take some Motrin or Aleve as we’re leaving and she has access to it and she said no, by the time she got in to the school building and I wasn’t even out of the parking lot I was getting a call from the school personnel asking to give her medication. So it’s really, she has a really hard time, predicting and gaging when she’s going to need something, whether it’s um being able to kinda predict her periods a little bit so she doesn’t link, or being able to understand that when she has a period, she gets cramps and she needs to almost pre-medicate to try to help her be as comfortable as possible.” Parent 6 (51)

**Speed Bumps on the Road through Puberty**

Participants shared experiencing ‘speed bumps’, unexpected or challenging incidents, on the road through puberty. One of several ‘bumps’ identified by both
daughters and parents were menstrual accidents. Daughters spoke of accidents as a by-
product of irregular or heavy menses. At times accidents could be embarrassing, but
some identified strategies to prevent their occurrence.

“I had like really, really heavy flow and I never knew when I was going to get it,
so my underwear kept getting ruined and it kept happening when I was at school,
so I was always afraid that I was gonna like, I was gonna leak and people would
notice.” *Daughter 4 (16)*

“Like, when I know like it’s gonna come I wear dark pants.” *Daughter 2 (15)*

Parents described incidents when their daughters had experienced a hygiene product
malfunction, such as miss use, use avoidance, and inability to predict when a pad needed
changing, that led to visible spotting on clothes and ultimately left their daughters open to
teasing or embarrassment. Additionally, this led to work for parents.

“I’m worried that there’s gonna be [an accident], you know. She’ll stand up and
there’s gonna be blood, her pants are gonna be bloody. Which they have been. I
mean they’ve called me. You know, [I worry] that she’s gonna humiliate herself
and not really understand it. It’s hard enough as a parent watching your kid be left
out, ostracized, but especially on that kind of front. And I don’t know that she was
embarrassed. It was just like really a hassle I think and she just didn’t want to deal
with it. She didn’t really want to accept that it had come and that she was having
to deal with it. It’s really [tough] watching it from afar as a parent, like I said, the
embarrassment of like leaking through your pants. I think I’m more [embarrassed]
you know, I think it affects me more than it affects her. But, I don’t want people
to look at her and judge her.” *Parent 9 (49)*

“Even recently, I’ve been dropping her off at school and I’ll see that she has a big
bloodstain on the back of her pants and I’ll tell her and she’s just more irritated
with the fact that she has to go home and change, she doesn’t seem to be
embarrassed that there seems to be a stain there. Surprisingly, they have never
called me. Quite often she does wear a hoodie, no matter what the temperature is,
so maybe that kinda covers it up. But, she doesn’t act any differently and it
doesn’t change her behavior really at all. I mean I just know because I find
disgusting things in the laundry.” *Parent 10 (43)*

Some parents have found that education and practice have decreased the occurrence of
such hygiene mishaps.
“[She had] more [accidents] when she was younger. She hasn’t had that problem at all in high school. I finally talked to her. She had an aid in middle school, and I told the aid, ‘Can you make sure that she goes to the bathroom?’ And she did. And things got better.” Parent 5 (51)

“She’s more worried about leaking, and so she will at times, we’ve discussed, you know I’ve found her wearing up to three pads at a time, and so we talked about how instead of doing that I could get like overnight pads, you know there was a different product, and so that helped. It was more of an anxiety about having an accident or leakage, than comfort. I was kind of surprised how she could walk around with three pads! Would’ve drove me nuts!” Parent 8 (46)

“A lot of it for [her] is awareness, and so now that she’s aware that ‘Whoops! You can have an accident’, or you could like have it through your clothes, um she’s more conscientious of what she wears, what color she wears or sitting on towels during like a heavy day. She does that all by herself now, I don’t have to do that. And I’ve noticed too, even in her bed, I don’t have to lay a towel out as much as I used to, she still likes me to do that underneath her sheets, but I haven’t [been] honestly quite as diligent as I used to be because the accidents and just less and less. So it was just a matter of getting it on just right.” Parent 2 (45)

Sensory differences also appeared as another ‘speed bump’. For daughters, sensory difference played a strong role in selecting hygiene products.

“Well, I like the thin pads. I like the pads that don’t feel like nothing, like nothing’s there. Those I like. I don’t like the really thick ones and are saying like ‘Oh! We’re here!’ like the really thick ones. That bugs me.” Daughter 1 (14)

Parents also spoke about challenges in finding and using the right feminine hygiene products, as well as problems with finding the right undergarments for their daughter.

“The biggest problem we have is trying to find pads that she can tolerate. Cause she’s very, she has a lot of sensitivities to materials, so just trying to find the right pads that she can tolerate the feel of. Because if [she] doesn’t like the way they feel, the material on them irritates her and bugs her, the sensation, you know the feel of it. So, she will just keep changing her underwear. And so, that’s the biggest struggle we have now is reminding her that she has to use pads.” Parent 3 (45)

“At first she didn’t want to use feminine products, so that was not good, but I convinced her that she had to, that’s just what you have to do. And then initially, probably I don’t know the first four or five months, she would hide her used pads in a drawer in her room rather than put them in the trash. I mean I would talk to
her about that and explain that this isn’t what we do, you know and why are you wanting to save them and she never, never would say and she just kept doing it and it finally took other people telling her that wasn’t acceptable, I actually asked various extended family members to talk to her too.” Parent 10 (43)

“[She] doesn’t like underwear at all, so she doesn’t wear it unless she has a period. And that was very concerning for me, that [she] up until her period, how she would deal with it, not only having the pad, but also have to wear underwear.” Parent 7 (43)

“She won’t [wear bras]. It’s all the sensory stuff: the shaving, the straps on a bra. So, at one point, I’m like ‘You have to wear something. You cannot just wear a t-shirt.’ And she doesn’t have large breasts or anything like that, but. So, we go to look, search for tank tops, you know just like little pull on tank tops that have no buttons, no shelf, no nothing. Right now we use just those little cammies, [they] don’t even have the built in bra cause she doesn’t like that either.” Parent 9 (49)

The last ‘speed bump’ identified by parents was their daughters’ resistance or disinterest in using tampons. Some parents vocalized feeling that using a tampon would make menses easier for their daughter, in terms of reducing accidents and promoting activity, but worried about whether their daughter would appropriately use them.

“I don’t think she’s old enough for tampons and I don’t know if she’d tolerate tampons anyway. Or if she’d change them often enough, which would then be a health risk.” Parent 3 (45)

“We haven’t even approached the topic of tampons. And I’m not sure when we’ll ever be able to reach that, but uh, little baby steps. She does Special Olympics here and um, they have swimming and they really wanted [her] to participate in swimming, but my concern was that she would not be able to swim during certain, you know if she had her period and they have meets and games and her period is due during the big game. So, I didn’t feel like she wanted to even really discuss tampons, I just kinda broached it and told her about it and she said ‘Uh-uh, no way, not gonna do it.’” Parent 8 (46)

“I’m frustrated that she’s so rigid. She won’t. I tried to show her. I mean there are a lot of videos and they’re pretty funny on YouTube about using a tampon. And, you know. You can use it. If you have a tampon you can actually go swimming in the summer. And she picks the pads that she wants. And like she said, she really likes the big ones. This, this giant purple wrapped Always thing. It looks like half a diaper. Umm, and there were days that, [the pad is] obviously an overnight thing, but she would wear that thing to school because it was the only thing that was
keeping her from going through her pants. You know like even [with] tampons, it would make your life so much easier. But, she just doesn’t care. So, I’ve tried different things. Especially with the tampon, that didn’t get me anywhere. I think the sensory [thing is an issue]. I think the thought of her sticking something in her is just beyond what she can deal with. I think her sensory stuff plays into the tampon thing.” Parent 9 (49)

Managing the Everyday

Parents and daughters reported many different experiences in managing menses, possibly reflecting different stages the girls were in post-menarche. Those who were further from the onset of menarche, and consequently had more practice, appeared to be more appropriately and effectively managing their menses. Several of the daughters shared using a calendar or an ‘app’ on a phone or tablet to track their periods. Parents explained that the use of a method to track their periods gave the daughters ownership of their periods and allowed them to plan more effectively.

“We have like this special app that helps us know, so we can be prepared. Have all the, the stuff ready, like the pads and the stuff that we need for periods. […] I like that it tells you like when your periods gonna start.” Daughter 1 (14)

“Well, I put like the first day it starts and the last day it starts and I have like this period calendar so that way it can tell you when your next period is gonna come, so I use that a lot.” Daughter 2 (15)

Other daughters were able to predict when their periods were going to start on their own and used other methods for getting ready.

“I just put on a back up pad. That’s easy. I always wear dark pants. No matter what’s the situation, I just wear dark pants cause dark pants are the only pants that I have. Just put a little dot on my calendar when my period starts and that’s it.” Daughter 6 (13)

“I can sort of sense it, I can, like I don’t count every week, but I can sort of be like ‘Oh, it’s been a while, my period’s probably coming soon’ and I don’t like, and I can just sort of sense, I don’t know why, you can just sort of sense, just feel it coming. I can just, around the time, cause I ovulate quite a lot, like almost, like only a week after my period ends I start ovulating, and I do it for quite a while, so
around the time that that ends, I know my period’s about a week away.” Daughter 7 (14)

Parents shared playing an active role in helping their daughter manage their menses, with some explaining that they transitioned to a more hands-off role as their daughter matured and became more comfortable and capable of taking on sole responsibility.

“I do [track her period] on like a little calendar on my wall, I’ll track them that way, but you know some times I forget to check off the days on the calendar and don’t realize, you know, what day it is or that it’s coming. She always carries some pads with her, but a lot of times we still end up with some pretty gross laundry. She doesn’t act any differently and it doesn’t change her behavior really at all. I mean I just know because I find disgusting things in the laundry. I’ll just ask her, ‘Do you have any, do you need more [pads]?’ and if there’s an obviously stain on her clothing I’ll tell her ‘Hey there’s a stain there, you’re going to need to change it’, but she just will easily make kind of a grouchy face at me and not say anything, just kind of ‘Ugh, fine!’ is the attitude. And if she’s running low on feminine products and I ask her she will tell me she will tell me, but if I don’t ask her she will not tell me. […] It seems like sometimes she doesn’t even accept that it’s happening at all. Ignores it.” Parent 10 (43)

“Until like a year ago I would say she was still [needing help]. So she had [her first period] when she was like thirteen? Twelve? She was around twelve, and even up until a year ago, so two years plus practice, she was still needing guidance. It wasn’t until this last year, this last school year, that I haven’t really given her that much guidance. So you know, meaning cues, like ‘Have you changed it?’ because she was still having [accidents]. You know, she’ll sit on my mom’s couch and it’s like ‘Oops! There’s something there.’ That was happening up until about a year ago. So [I’m] still having to give her some guidance. I would say in terms of other girls, I wouldn’t think it would take that long, I think it does take longer with girls that have ASD to get that right.” Parent 2 (45)

“I suppose because we had so much anxiety about it, that um, it’s easy because [she] completely takes responsibility for it, and keeps herself clean and I don’t really hear anything about it. Um, so it hasn’t been any drama. Um, yes, very independently. She might change pads a little (.) um too frequently, but I’ll take that.” Parent 7 (43)

“She manages, you know even from the very beginning she has managed them a lot better than I initially expected. She has taken ownership of it and is very vigilant, almost sometimes a little too vigilant with checking her pads. So sometimes it’s ‘Um really? You just went to the bathroom 10 minutes ago, you don’t need to check again’, but she gets concerned, cause she doesn’t want
accidents. So [she’s] very good, very good. But then sometimes forgets like she’ll have her period and we’ll be out and she’s like ‘I have to go check’ and I said ‘Do you have any extra pads?’ and she’ll be like ‘Oh no, I didn’t bring any!’ So, with practice she’s gotten really good with that.” Parent 8 (46)

Some parents shared the role that medication plays in managing both their menses and the accompanying symptoms.

“I think I might have talked to her pediatrician, who referred me to a gynecologist that that works with girls with Asperger’s. So yeah, we went there and then she suggested that [oral birth control] would be the best bet because keep trying to keep track, I just, I don’t know, [was so] anxiety-ridden. She’s anxiety filled anyway, so that was just too much to have to worry about that. It’s hard to tell sometimes, but, she’s still irritable, maybe not to the full extent that she was before, but definitely still irritable. But the anxiety, about when she is gonna get it, you know still a little bit you know probably with weeks, so that a concern, but I don’t think it worries [her] like it did before.” Parent 4 (50)

“I took her to the [doctors], we had to talk about it when I took her to the doctor to get her on the pill. Kind of explain why, why you’re taking this pill and you know, to make [her period] less and there are other options too to make it even more less. I wanted to start with this one. But you know it’s, it’s more just you know, just maintenance. It’s maintenance.” Parent 9 (49)

“[We] actually just upped her medication of her [anxiolytic] which seems to be helping quite a bit, along with her [SSRI] and that has helped tremendously just this past month and this period, the week before was not near as difficult as it had been. So, when I initially got her put on medication for the anxiety and then went back to the psychiatrist at [care network] um, it was specifically, very specifically, this PMS is horrible for this child, and so then he put her on the [anxiolytic] and so that combination seems to be helping.” Parent 1 (44)

Some parents shared that hygiene could be a challenge for their daughters, noting that they struggled helping their daughters understand the need for hygiene and how to manage hygiene related issues, while others felt their daughter had assumed the new responsibility well.

“It’s just, you know, it’s kind of the whole personal hygiene thing. You and I really care about our hair. That we don’t smell. That’s just kind of a foreign concept [to her]. Ok, like taking a shower, she loves taking a shower, but it’s the mechanics of the personal hygiene. She will shave her armpits, but she leaves ¾
of it still there. She washes her hair. But it’s like two seconds of three fingers in her hair and then that’s considered a wash to her. The reasons behind it, like so you have clean hair and you get it all out so that your hair is not greasy. And we wash our face so that you know it’s clean and we don’t get zits. That’s beyond the comprehension. Like the why we do it. […] It’s not the “this” or “that”. It’s that if you have clean hair, you don’t look like a slob. They’re not trying to impress anybody.” Parent 9 (49)

“[She] is really very, very clean child and so she doesn’t like germs and messiness and that kind of thing, and we’re worried about getting sick and all of that, and so she struggles with anxiety in those areas. So how that impacts her period she is very quick to change her pad, which is good, but sometimes it’s a little premature or she worries, you know, I tell her that if it happens at night it’s no big deal cause I showed her, you can put a towel down, cause that’s what I did, still do it, put a towel down under your sheet and sleep on top of the towel and then you don’t mess up your sheets, and then I’ll just wash the towel and her clothes and no biggy, you know, no problem at all.” Parent 8 (46)

Daughters felt that having periods had an impact on their daily lives, limiting their activity or keeping them from things they wanted to do, particularly during the summer when they wanted to go swimming.

“Well tonight I was supposed to go to a pool party but I can’t cause I’m on my period. It makes me feel left out, but I mean … It was for like girl scouts, so I mean, all girls have their period. So it makes me feel left out, but there’ll be other times, so I think about all the other times I can go.” Daughter 2 (15)

“[You] can’t do much with your period, like you can’t do as many activities as you do when you don’t have the period. Like, if I do anything like jumping or anything that involves more sports or something like that the blood, the period, just shoots out sometimes, I don’t know. Yeah. I’m so happy it’s the last day of my period, it’s like a ‘Hallelujah’ moment every single month.” Daughter 1 (14)

“I feel less mobile, cause the underwear I find very restricting and pad very restricting which is kind of annoying. But you know, I put up with it because I don’t have much of a choice. […] My [sibling and friend] were going swimming at a public pool and I couldn’t go, cause I was having a pretty heavy day and I was kinda bummed out about that. But swimming is the only thing it really gets in the way of. Which is a problem, I mean it’s a problem sometimes, cause I love to swim.[…] I mean it might interfere slightly with the movies, cause that requires more bathroom breaks, but otherwise, not really. I go to movies a lot, there’s no stopping me. I love movies.” Daughter 7 (14)
Parents saw that periods sometimes limited their daughters’ activities beyond the play activities noted by daughters, but coached them on how to not let their periods significantly limit their lives.

“She’s expressing concerns, like she can’t go to track practice or basketball because ‘I have my period’ and we talked about that you can’t stop living when you have your period and so you can [still] do those things, and just you know make sure that you’re fully prepared. If I let her, she wouldn’t have gone, but we made her go and then she realized that she didn’t have to let it stop her. But she’s more resistant sometimes when it comes to physical activity or going places, she’ll be like ‘Oh well, I can’t go out with you guys because I have my period’ and I’m just like ‘Oh well, it’s portable, so let’s go!’ So just walking her through that.” Parent 8 (46)

**Looking Forward**

Daughters spoke little about the future or what the future might hold for them.

One participant rejected the idea of having to grow up.

“I never wanted to grow up. But [with] puberty, I’ve already sort of been there, done that and I just think of growing up, and I’m only growing up physically. I mean I can at mature, kind of, in public, but I still love fart jokes, I still bathe with a thousand rubber animals, I still have my blankey which I need to fall asleep, and I still suck my thumb.” Daughter 7 (14)

Others viewed growing up more objectively, seeing puberty as a process with potential benefits.

“Well, once you get older you start to feel more mature, and your body’s changing and you start to notice something different about yourself.” Daughter 5 (15)

In response to a direct question included in their interview guide, parents shared diverse thoughts on their daughter growing up. For some, seeing their daughters overcome so much in the past was a source of pride and hope.

“You know, she’s discovered a lot of, a lot of talent with art and animation, and it’s become her passion, and she’s really quite good and [it’s] exciting seeing her making plans, you know where she wants to go to college and deciding to take
summer school classes so she can open up her schedule for more electives. I’m excited for her to see who she really is, being able to apply herself in something that makes her happy.” *Parent 6 (51)*

Some offered conflicting feelings about what the future might hold, expressing that a lack of a known future was a cause for both worry and hope.

“[My feelings are a little] mixed, because I don’t know where she’s going in life, but we’ve got lots of hopes. She has come so far and dealing with so much, and I don’t know where she’s going yet, so I have some, you know, worry, just not knowing what that’s going to look like.” *Parent 7 (43)*

“[I’m] excited and scared. Excited because she’s exceeded so many expectations and done so well. Nervous or scared, because I don’t know. I don’t know where she’s gonna go. I think she’s going to do a more non-traditional path, I don’t know that she’ll go to college, but I know she’ll do something and so it’s just, the scared-ness is not knowing [what] her path is, finding her path for her. With her and for her, you know, getting her there.” *Parent 8 (46)*

“She’s very intelligent for her age, I would say that she’s way above her classmates in book knowledge, but she’s very immature and so I worry when she gets out in to the world what will happen to her, and if she’ll be able to really take care of herself, because she does forget, I have to remind her about all sorts of things and, I just hope she’ll be responsible enough to live on her own and take care of herself.” *Parent 10 (43)*

Parents also shared thoughts about potential future romantic relationships for their daughters.

“I guess I’m somewhat relieved that that part of [her] body works too. That, you know, eventually she’ll be capable and able [to have children]. I mean, that’s what you hope for, eventually have the opportunity to have children herself. I don’t find it scary [and] I don’t feel fearful for her getting pregnant for anything. Some of that is because, maybe it’s a little naïve on my part, but I think that because of her level of maturity I think that’s just so down the line from now. I think that by the time she really wants to engage in having sex or whatever, it’s going to be later.” *Parent 2 (45)*

“She told us after [a health class] that she wasn’t going to date until after she graduated from college and she had a good job. Well that’s a really good goal, but I don’t think that’s going to happen. But okay! I am concerned that the physical attraction and the hormones that go with that, of things becoming overwhelming to her, and she has impulse control issues and so on, that it could provide for just
some very difficult transitions.” Parent 6 (51)

“I don’t know that she puts together having your period means that you can have a baby. Which, [you] need to do. And I have the books, like I said, she just totally changes the subject on that. So that’s why I fear things. She could [get pregnant], I mean. I worked at a shelter with kids [and] adults with disabilities. They have the urges, yet they don’t really manage them appropriately.” Parent 9 (49)

Reflective Advice

When asked what advice they might offer a friend going through puberty, many of the daughters reinforced the normality of puberty.

“Don’t be scared, you’ll just be fine, it’s normal.” Daughter 3 (14)

“Puberty happens to everyone, and you’re not alone.” Daughter 4 (16)

“It happens to all girls. You’re getting older and your body’s gonna change over the years, and sometimes you just have to be prepared for the worst and just hope for the best.” Daughter 5 (15)

Others offered advice on what to do once a girl has her period.

“Don’t be nervous. You’re gonna have cramps so you should have a heating pad [or] ask your mom if you can have Advil. Sometimes if it’s really bad, bring extra pads where ever you go, if it’s at a friend’s house or at school [or whatever]. Keep it like a secret, don’t tell any boys because the boys would have no clue what you’re saying.” Daughter 1 (14)

“Keep feminine products with you, cause you never know when you or someone else are going to need it.” Daughter 10 (16)

“I would say just don’t freak out when you have it. I mean like the first time you have it. I’d say always bring like pads with you, cause that’s what I do I bring pads with me. So, just always be prepared. Yeah, just always be prepared and don’t freak out.” Daughter 2 (15)

Parents also had words of wisdom to offer other families of girls with ASD. Advice frequently focused on the importance of preparing daughters for the upcoming transition to womanhood, and the role that parents and others could play in educating daughters for the transition.
“Well, be honest with them. I know that that’s hard with a lot of parents, and you know if it’s hard for you to be honest with them, or to have that talk with them, ask someone, either one of their providers or somebody that you trust to start having those discussions with them. Because misinformation is bad for a Neurotypical kid, it’s really bad for our kids. You know, because that makes them a lot more vulnerable.” Parent 3 (45)

“I would say be very open to talking about it and exposing your child to different ways of discussing it. I mean, it’s important that mom and dad have conversations with their children, but the educators in the public school to give it their try and the nurses. When I saw opportunity for [a] video, I thought [since] she’s always been such a visual learner, I thought this is really great, because the more we can discuss it then she can get more comfortable with it. Everyone presents it in a little different way, and I thought she picked up information from each source a little bit differently.” Parent 8 (46)

“Make sure you that you talk about it. Frequently. Make sure that you use visuals of some sort because they’re typically visual learners.” Parent 1 (44)

“I mean my biggest thing is using the resources that surround you and not being afraid or being too overly protective that those resources can’t help you. Meaning, you know, your pediatrician, [or] nurses at the school. Having them be involved and part of the process, I think it takes a lot off of the mother, the parent, cause that’s a lot to bear. So in terms of instruction and really paying attention, I really think it’s because it came from someone else and didn’t come from me. It doesn’t necessarily always have to be parent driven, conversation can happen outside of you.” Parent 2 (45)

Some parents emphasized the normality of puberty for their daughters, letting the experience be a way in which they were like all their peers, instead of a way in which they were different.

“We get caught up being parents of kiddos on the Spectrum, especially girls, because most of the information is about boys, and we get caught up into all of the therapies and all the extra stuff that they need and the IEP meetings and everything, when sometimes it’s okay to just sit back and just let things happen. And that’s kind of how I’ve approached her period, and for us, it’s worked.” Parent 6 (51)

“Just normalize it as much as you can. Because it is what our bodies do and, you know, if you can normalize it as much as you can, then that’s not something else that’s abnormal about them.” Parent 3 (45)
Others offered strategies on how to best meet the needs of those with ASD in understanding and coping with the pubertal transition.

“So it is definitely, especially for our kids on the spectrum, it is not a one shot deal, this is something to be discussed several times before, and then obviously when it happens. I think she handled it so well because one of the reasons was because she was so well prepared.” *Parent 8 (46)*

“Be prepared for heightened sensory, you know like try to do things ahead of time. Oh that’s another thing I did, I did get panty liners for her before she got her period and we would have her try to wear them, didn’t work out too well, she didn’t want to, but she tried! She tried them out. And, you know same thing with a training bra and things like that. Early!” *Parent 1 (44)*

“Keep talking, keep talking even if the person with Autism Spectrum Disorder doesn’t answer you, just keep talking to them.” *Parent 10 (43)*

**Discussion**

This study was the first to investigate puberty for adolescent females with ASD through their own and their parent’s perspectives. Codes were organized into the thematic categories of (1) preparing for puberty, (2) speed bumps on the road through puberty, (3) physical experience of menses, (4) managing the everyday, (5) looking forward, and (6) reflective advice. These themes and the experiences shared appear to be unique to females with ASD; for example, while Neurotypical females and males with ASD may also prepare for puberty, the quality, topics, or extent of education in the preparation differs for females with ASD. Overall, the daughters spoke of puberty and periods with a matter-of-factness. Some expressed resignation at having to deal with the hassle of periods, the monthly management, or the annoyance of growing up, but acknowledged it was a reality they had to address. Parents shared a wider variety of experiences and points of view on puberty for their daughters, ranging from an easy transition with open discussion, to struggles with finding and using feminine hygiene products and challenges
in helping their daughter understand and adapt to changes in their bodies. Regardless of the difficulties they faced, all mothers shared the importance of talking with their daughters about puberty and normalizing the experience.

**Key Findings**

**Dynamic Differences.** While the stories shared by the parents and daughters in the study had overlapping elements, each family experienced their own unique challenges in navigating puberty. As no two cases of autism are the same, it appears that the interface between ASD and puberty is similarly distinctive. For example, though many of the participants shared challenges posed by sensory differences in the daughter, the impact of the differences played out in very different ways between girls. Where one participant’s tactile hypersensitivity made finding comfortable feminine hygiene products extremely difficult, another’s hyposensitivity left her prone to accidents because she was unable to sense when her pad needed changing. For another, hypersensitivity meant regular struggles with her mother on topics like shaving and yet for a fourth, sensory differences resulted in rejection of wearing bras. Understanding that the same underlying mechanism can play out in such different ways is important for both families and practitioners who work with this population to recognize. It highlights that issues that arise in puberty may have an unexpected origin and it’s important to explore what may be causing difficulties from a variety of perspectives.

**Role of the Mother.** Both daughters and parents repeatedly shared that mothers play a central role throughout puberty. Mothers were not only educators, serving as both primary and secondary sources of information regarding pubertal changes, but also as
sounding boards for their daughters, emphasizing normality of puberty and normality of
their daughter. Daughters spoke of their mother as a “key-stone” figure, someone who
they could rely on and check in with should they have questions or concerns. In telling
the story of their first period, nearly every daughter immediately told their mother, some
with fears or questions, some with excitement. Parent-participant dyads that shared
having an open, accessible relationship when it came to discussing puberty and menses
were more likely to speak of the process in more positive terms. Mothers also played a
key role in managing menses with their daughter. This role included tracking their
daughter’s cycle and reminding them when periods were expected, reminders to wear
pads when anticipating a period, providing a structured schedule for changing feminine
hygiene products, and ensuring that their daughter had access to specific hygiene
products and medication to manage symptoms. Some were able to phase out their
involvement as their daughter’s matured and assumed increasing responsibility, while
others continued to be active in management over time. The role of the mother was a
constant throughout all of the themes identified in the study and underscored close
relationships between mothers and daughters throughout puberty.

Strengths and Limitations

This study does have its limitations. While participants were purposefully selected
to achieve a measure of heterogeneity, the group was predominately Non-Hispanic White
and the study findings may not speak to experiences of individuals outside this group.
Meanings and cultural attitudes towards menses vary widely across cultures; all
participants were located in the United States (nine states from the Pacific Coast,
Southwest, Great Plains, New England, Mid-Atlantic and Southeast regions) and findings of this study may not be appropriate or accurate outside of a Western cultural setting. All parents participating in this phase of the study were mothers and may have shared experiences reflecting a distinct role and relationship with their daughters on issues like puberty and menses that are key components of womanhood that may or may not be shared by fathers. While parent-participant dyads with fathers as parent participant were sought, none elected to participate in the interviews. The daughter participants here also were from a narrow age range, 14 to 16 years old, and their experiences may be specific to the early menstrual years. While the age range was largely due to inclusion criteria, future studies would do well to look at the experience of menses and being a woman with ASD across the lifespan, from early childhood through late adulthood, to explore how understanding and perceptions may shift over time. From anticipation of menses in late childhood, to loss of menses in menopause, women across their lives may have strikingly different relationships to this central tenant of womanhood, and it is an important next step for this area of research to explore how this may present for females with ASD.

The semi-structured interview format was a challenge for some of the daughters. While the researcher made every attempt to promote participant comfort, provide clarification and ample time for reflection, the brevity of responses from some participants suggests that they may prefer alternative options. Future studies may consider piloting several different methods to identify the most productive method for data collection. Such methods may include an open-ended questionnaire or essay format for participants to write their experiences, providing the topics to participants ahead of
the interview for reflection, or group interviews where girls can openly discuss topics. Another possibility includes ‘loop-back’ interviewing, where the interviewer engages in two or more interviews with the participant so as to build a trusting relationship for discussion of sensitive topics and give the participant opportunity to reflect on material discussed in earlier interviews.

**Conclusions**

Like the process of puberty itself, the themes identified in this study highlight a number of issues that occur over the span of many years and the shifting needs and roles that both daughters and parents have throughout the process. The daughters and parents interviewed emphasized the importance of preparing for puberty, drawing from a number of resources to help daughters understand what to expect as they grow up. Where daughters expressed experiencing more menstrual symptoms, parents noted that pre-menstrual symptoms, particularly emotional changes and anxiety, were also present. The transition through puberty is rarely smooth, and participants noted several ‘speed bumps’, including menstrual accidents, ASD associated sensory differences and resistance to the use of tampons. In working to promote menstrual management, both daughters and parents noted the key role that mothers played on a daily basis. Parents also looked to the future with hope and trepidation, balancing concerns against progress their daughters have made in the past. All participants offered words of wisdom to other girls with ASD and their families, offering a glimpse into what practitioners and parents can do to provide support. To provide quality care and support to these families, it is vital to recognize not only the variations that happen across puberty, but also the unique
experience of each family. Practitioners at all levels should dedicate time to explore the strengths and struggles of each family and facilitate discussion on alternative strategies that can be implemented to meet the needs of these young women.

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CHAPTER 5.

Conclusions and Implications of Findings
Introduction

A review of the brief published literature on puberty in females with Autism Spectrum Disorder (ASD) shows mixed findings on key issues, including age at menarche (AAM), menstrual symptoms, and rates of gynecologic disorders in the population. While two studies have reported increased rates of early onset and precocious puberty (Hamilton et al., 2011; Pohl et al., 2014), others have demonstrated an increase in AAM for females with ASD (Hergüner & Hergüner, 2016; Ingudomnukul et al., 2007; Knickmeyer et al., 2006; Whitehouse et al., 2011). Irregular cycles, dysmenorrhea and menorrhagia appear to be more common (Burke et al., 2010; Hamilton et al., 2011; Ingudomnukul et al., 2007; Pohl et al., 2014), and females with ASD and mothers of children with ASD may have higher rates of hirsutism and polycystic ovarian syndrome (Ingudomnukul et al., 2007; Pohl et al., 2014). However, the few studies that have addressed these issues are limited by study design, including small sample size (Burke et al., 2010; Knickmeyer et al., 2006), reliance on proxy populations (Hergüner & Hergüner, 2016; Whitehouse et al., 2011), lack of control of variables known to influence menses (Burke et al., 2010; Hamilton et al., 2011; Hergüner & Hergüner, 2016; Knickmeyer et al., 2006; Whitehouse et al., 2011), and inconsistent definitions of key terms. The Facing Puberty Study sought to address the gaps in the literature with an explanatory sequential mixed-methods design, combining self and parent-report on web-based questionnaires with semi-structured dyad interviews on the onset, symptoms and experience of menses for this unique population. This study was the first to simultaneously assess onset and presentation of menses in adolescent females with ASD,
using self and parent report compared to a Neurotypical control group. Further, it was the first to use semi-structured interviews with parent and daughter dyads to understand the experience of puberty for females with ASD.

Four key findings were drawn from this study: (1) earlier age at menarche in females with ASD and females of siblings with ASD, (2) differing perception of menses and menstrual symptoms between mothers and daughters with ASD, (3) challenges in menstrual management, and (4) the unique impact of impairments and differences associated with ASD on puberty and menses. While the findings from the study are discussed at length in the manuscripts previous to this chapter, a review and summary is provided here to link findings across the Quantitative and Qualitative Phases of the study.

**Findings**

**Age at Menarche**

Compared to Neurotypical (NT) peers, females with a diagnosis of ASD in their family, either for themselves (AS group) or in a sibling (AS:AS and NT:AS groups), reported earlier age at menarche. Females with ASD from multiplex families experienced menarche 1.85 years (or 22.2 months) earlier than females with no history of ASD in the family. Further, significantly more females from multiplex reported AAM meeting criteria for early menarche (≤ 11 years) than those from simplex families and those with no family history of ASD. Parents from both AS and NT groups were accurate reporters of their daughter’s age at menarche. In the interviews, mothers spoke of preparing themselves and their daughters for experiencing early menarche. For **Parent 3**, drawing on family experiences helped guide them, “She had one cousin that started her periods at
eight, [so] I didn’t know when she would start hers, anywhere early like that up to, well I was 15 when I started mine. So, we started the conversation early.” Parent 5 also expressed disappointment and remorse for her daughter having experienced menarche at an early age, “Oh man. TEN. Really?! It’s been a very maturing experience for her”. Daughters who experienced early menarche spoke of the experience matter-of-factly, such as Daughter 3, “I was down at a friend’s house and I was 9 years old and I went, and there was blood. Yep. And after that we went to Walgreens and got pads.” Others conveyed a more emotional experience, like for Daughter 5 “Well, [I was] anxious. ‘Oh, what’s gonna happen to my body?’ When I first started my period, I felt like ‘Oh, what’s happening?’ and ‘Why is it there?’ And, and [then] my mom talked to me about it and I understood what it means. […] I felt scared. I felt like something was wrong. [But then] I showed my mom and she told me I was starting my period and then she told me all about it.”

The trend towards earlier onset of menarche observed in females from multiplex and simplex ASD families suggests a potential underlying developmental mechanism shared between ASD and AAM. Both AAM and ASD are highly heritable and it is plausible that with increased genetic load, the risk for both ASD and early AAM may increase. AAM has been associated with a number of genes implicated in or near genes implicated in BMI, energy homeostasis, and hormonal regulation (Elks et al., 2010). Hormonal regulation genes, such as RORA (Sarachana, Xu, Wu, & Hu, 2011), and obesity genes (Persico & Napolioni, 2013) have been linked to occurrence of ASD. While elucidating the underlying genes is a fundamental step forwards with this research,
ultimately, the mechanisms by which these genes may lead to ASD and early onset AAM is essential for understanding the complex effects of ASD on the health and well-being of those with the disorder.

**Menstrual Symptoms**

Females from multiplex and simplex ASD families reported experiencing fewer premenstrual, dysmenorrheal, or physical menstrual symptoms than NT peers, and behavioral and emotional menstrual symptoms at similar rates to NT peers. Within the AS groups, multiplex participants reported significantly more physical menstrual symptoms than simplex participants. Multiplex participants also had the greatest proportion of participants experiencing ‘Significant Burden’ for behavioral and emotional menstrual symptoms and report any level of burden for dysmenorrhea. This demonstrates a potential shift in presentation for females with ASD towards fewer premenstrual symptoms and greater menstrual symptoms, specifically for dysmenorrheal, behavioral and emotional symptoms. With parent report of menstrual symptoms, NT parents consistently reported fewer menstrual symptoms across all assessed areas, with the exception of change in mood before a period, compared to their daughters. In contrast, parents of females with ASD reported significantly more pre-menstrual symptoms and fewer physical and behavioral menstrual symptoms than their daughters. AS parents reported more emotional changes over the menstrual cycle, including changes in mood before and during a period and irritability, compared to their daughters, though these differences were not significant.
It is interesting that within the menstrual symptom sub-groups, only physical symptoms show virtually no difference between all four groups. Physical symptoms, which include bloating, cramps, constipation, and headaches, may be more challenging for females to perceive and report due to differences in bodily perception that have been noted for individuals with ASD (Allely, 2013; Courtemanche et al., 2016; Moore, 2015; Yasuda et al., 2016). Alternatively, they may experience these symptoms regularly and independently of the menstrual cycle and therefore do not perceive them to be associated with menses. For example, previous research has reported greater levels of constipation for individuals with ASD compared to NT peers (Ibrahim, Voigt, Katusic, Weaver, & Barbaresi, 2009); for a female with ASD who is regularly constipated, she may perceive no difference when she has her menstrual cycle. Both of these hypotheses were supported in interviews with the participants, however they differed by reporter. While parents shared experiences that promote the ‘atypical perception and communication’ hypothesis, daughters offered experiences in keeping the ‘constant symptom’ hypothesis. Parent 4 shared that she feels it may be more of a communication deficit, “You know she does sometimes have trouble verbalizing what’s she’s feeling, so I don’t know if that [plays a role].” Another mother, Parent 1, also shared that communication, as well as atypical perception, may be driving the difference, “I think she experiences less, but it’s hard to say how much of that is a communication, you know, not telling me about it, versus not feeling the pain.” Parent 8 also shared similar thoughts, “I […] think that she experiences very little pain, it’s very surprising to me, how little she complains about that.” In contrast, Daughter 7 stated, “[I feel] pretty much the same. There’s not really much
change. I honestly would have expected more change, if you had asked me when before I had my period. I probably would have been quite nervous about it, been like I’ve got, it’s probably gonna be bad, but if you ask me now, it’s just sort of an ‘eh?’.” Daughter 2 and Daughter 6 had shared similar thoughts: “It doesn’t really.... feel anything, just like on the second day or third day I’ll start getting cramps but like... that’s kinda it” (Daughter 2) and “Except for the cramps, I don’t feel really anything at all” (Daughter 6).

**Pain.** Due to the potential differences in sensory perception and reporting of pain with individuals with ASD (Allely, 2013; Courtemanche et al., 2016; Moore, 2015; Yasuda et al., 2016), it is important to look closely at reports of menstrual pain among the groups. Compared to NT peers, AS groups had lower levels of menstrual pain (Scale 0-10: NT = 5.25 ± 2.49, NT:AS = 3.97 ± 2.64, AS =3.91 ± 2.66, AS:AS = 4.75 ± 2.60), yet reported utilizing OTC pain medication at greater rates (NT = 33.3%, NT:AS = 54.3%, AS = 45.4%, AS:AS = 62.5%). Parents’ reporting also followed this trend, with lower levels of pain in the AS groups, but greater utilization of OTC pain medication. This suggests that participants may have differences in the perception and/or expression of pain broadly, or perhaps perceive menstrual pain as less severe than other types of pain, while still meeting the threshold for treatment. As noted above with perception of physical menstrual symptoms, parents frequently reported a surprising lack of communication of pain by their daughters and often described their daughters as having an atypically high pain threshold. Parent 10 said, “Her pain threshold is a lot higher than other people. When she was little would run and fall down and get a scraped knee, she would most of the time just like ‘Oh, I’m fine’ [and] get up, where most little kids would
be crying, and she runs cross country and track in school and she can just go and go and go and go.” Parent 6 shared the memory of when her daughter had broken her leg, “She has a really high threshold for pain […] with her femur being broken, and it was completely separated from the bottom of the bone. She was trying to walk on it.”

**Impact on Daily Life.** Participants from all groups reported generally low levels of menstrual interference with activities of daily life, with the exception of sports. Though AS participants reported lower levels of menstrual interference with sports than NT peers, they expressed dismay and resignation that menses inhibited certain activities, like swimming. As shared by Daughter 7, “My brother and his friend were going swimming at a public pool and I couldn’t go, cause I was having a pretty heavy day and I was kinda bummed out about that. But swimming is the only thing it really gets in the way of. Which is a problem, I mean it’s a problem sometimes, cause I love to swim.” In contrast, parents of both NT and AS participants perceived more interference of the menstrual cycle in attending school and relationships with friends and family, as well as completing school work, social activities, and sports for parents of AS participants. Parent 8 summarized these differences with her daughter, “She’s expressing concerns, like she can’t go to track practice or basketball because ‘I have my period’ and we talked about that you can’t stop living when you have your period and so you can [still] do those things, and just you know make sure that you’re fully prepared. If I let her, she wouldn’t have gone, but we made her go and then she realized that she didn’t have to let it stop her. But she’s more resistant sometimes when it comes to physical activity or going
places, she’ll be like ‘Oh well, I can’t go out with you guys because I have my period’ and I’m just like ‘Oh well, it’s portable, so let’s go!’ So just walking her through that.”

Though differences between parent and daughter perception of menstrual symptoms and their subsequent impact on activities of daily life were apparent, considering the impairments in communication and differences in bodily perception for females with ASD, they are not entirely surprising. While parents of Neurotypical females consistently reported fewer symptoms and less impact of menses, this trend did not hold true for parents of females with ASD and highlights areas for future research to address.

Menstrual Management

Parents and daughters interviewed in the Qualitative Phase universally spoke of challenges in managing menses. While this challenges were varied, from refusing to use feminine hygiene products to dramatically increased anxiety prior to menses, they all resulted in complicating menstrual cycles. One issue that frequently surfaced for interviewed participants was the difficulties in hygiene product use. This was mirrored in the Quantitative Phase, in a section within the MDOT where participants responded to a series of statements about their menstrual cycle as ‘True’ or ‘False’. This analysis fell outside the scope of the quantitative manuscripts and was prompted by the findings in the Qualitative Phase, and is presented here. Females with ASD expressed significantly less interest in using tampons than NT females (“I am not interested in using a tampon”; ASD = 67%, NT = 38%, $\chi^2(2) = 6.77, p = 0.03$) and were less likely to report only using tampons (“I only use tampons”; ASD = 0%, NT = 21%, $\chi^2(2) = 7.84, p = 0.01$). While the
majority of females with ASD preferred to only to use pads ("I only use pads"); ASD = 82%, NT = 60%, $\chi^2(2) = 3.74, p = 0.05$), many of them had difficulties in using them ("I have difficulties using pads"); ASD = 27%, NT = 4%, $\chi^2(2) = 8.90, p = 0.00$). These differences may stem from sensory differences and challenges with fine motor skills often seen in individuals with ASD (Stevenson; Leekam; Ming; Provost). Daughter 7 shared having difficulties with pads, noting “I have trouble arranging them in a way so there’s no spill over.” Parent 3 noted it was sometimes difficult to get her daughter to use pads because of the discomfort they caused, “She doesn’t like the way they feel, the material on them irritates her and bugs her, the sensation, you know the feel of it. So, she will just keep changing her underwear. That’s the biggest struggle we have now is reminding her that she has to use pads.”

Possibly in response to these challenges, participants reported that mothers played a significant role in their daughter’s menstrual management. Mothers played integral roles for their daughters in helping them learn about, adapt to, and cope with menses. Mothers were often noted to be the first person the daughter shared news of menarche with and were typically the primary source of information and education for their daughter. After menarche, mothers and daughter noted that the mother played very active roles in managing the daughter’s menses, including reminding them when they may start their period, suggesting to wear a smaller pad when periods were anticipated, reminding daughters to change pads regularly, providing pads and pain medication for symptom management, and tracking their daughters cycle. Some of the mothers noted transitioning to a less active role as their daughter aged, such as checking in once or twice a month to
ensure that their daughter had sufficient supply of hygiene products, while others
maintained an active and present role across time, often adapting earlier strategies as their
daughter’s environment changed. One mother developed a system of texting with her
daughter’s aide and teachers to remind her to check her pad every two hours. These
strategies, though at times burdensome for the mothers, helped females with ASD more
appropriately manage their cycles.

**Different Paths through Puberty**

Just as no two cases of ASD are the same, the impacts of ASD on puberty varied
across participants in the study. It appears that the individual’s ASD “drives” the
experience of puberty. The insistence on sameness, highly restricted interests, challenges
with social-emotional reciprocity and non-verbal communication, hyper and hypo-
reactivity to sensory input all modulate how the individual encounters puberty. For
example, if the individual is highly resistant to change, has decreased interest in social
communication, and tactile hypersensitivity, those differences have direct effects in how
they respond to and cope with puberty: they may require more education and intervention
prior to starting their period about what periods are, why they will have them and what
can be done to mitigate accompanying symptoms, they may need education from a
variety of sources, both verbal and written, and they may struggle with finding bras and
feminine hygiene products that are comfortable for them to wear. In this way, how their
ASD presents may, to an extent, inform how they experience puberty and menses. Some
of the parents verbalized knowing that certain components of puberty would present a
challenge due to their child’s differences. As Parent 9 noted in trying to work with her
daughter on using a tampon, “I’m frustrated that she’s so rigid. She won’t. I tried to show her. I mean there are a lot of videos and they’re pretty funny on YouTube about using a tampon. But she will not have any part of it. That’s what’s frustrating.” Though she felt she had her daughter’s best interests at heart, they couldn’t get around or work with her daughter’s rigidity. Other parents however noted that their daughter’s preference for sameness and adherence to routine helped them, such as for Parent 7, “She might change pads a little too frequently, but I’ll take that.” This highlights how the same hallmark symptom from ASD had very different outcomes in different participants.

**Study Strengths and Limitations**

This study is the first to characterize in substantial detail the onset and presentation of the menstrual cycle in females with ASD compared to Neurotypical peers using self- and parent-report. Further, the study controlled for variables known and hypothesized to be associated with AAM, strengthening our primary finding of earlier onset in females with ASD from multiplex families. Earlier literature on the subject have relied on the use of proxy populations, as with Whitehouse’s and Herguner’s use of Neurotypical subjects compared across level of ‘autism-like’ traits, or review of medical records (Burke et al., 2010). Previous studies have also lacked Neurotypical comparison groups (Burke et al., 2010; Hamilton et al., 2011), omitted reporting of AAM (Ingudomnukul et al., 2007; Pohl et al., 2014) or menstrual symptoms (Knickmeyer et al., 2006). Further, this study was the first to explore the experience of puberty through qualitative methods, in semi-structured interviews with parent-participant dyads. Through this study, a fuller description of the presentation and experience of puberty for females
with ASD has been achieved. While participants represented a narrower racial and ethnic make-up that initially desired by the researchers, being predominately Non-Hispanic White, due to the known association between AAM and race and ethnicity, this helped to control for influencing variables and strengthened the findings on AAM and ASD. In addition, these results can be generalized broadly to the female ASD population in the United States, which is predominately Non-Hispanic White (Christensen, 2016).

The use of a web-based platform for questionnaires was novel to this population and was selected to promote comfort and accessibility for all participants. Openly discussing the menstrual cycle remains a taboo topic in the majority of Western cultures (Houppert, 1999). Through the web-based platform, participants could take part in a private setting and would not feel pressured to respond according to cultural norms. However, the web-based platform and the anonymity that accompanies it unfortunately resulted in the study being vulnerable to fraudulent participants. Several checkpoints were built in to the study, including a brief 5-question screener and consent/assent forms that required the participant’s email address. Participants were sent individualized links to the password-protected website and a separate password-protected page to claim the $10 compensation for participation, ensuring only those completing the study could claim compensation. It appears that an individual or group of individuals located within a small geographic location learned the responses necessary to move through the screening questionnaire to consent/assent and were subsequently given access to the study website. After completing the questionnaires, they accessed the gift card page and claimed compensation. In reviewing their completed questionnaires however, it was apparent that
they did not meet criteria for participating in the study, such as reporting birthdates outside of the 18 years of age maximum, or reporting that the participant was male where only females met inclusion criteria. Further, data from these individuals for the study questionnaires appeared to be filled in at random, the built-in repetition of key themes showing conflicting answers between questions on the same topic. Ultimately, four parent-participant dyads, all from the AS group, were dropped from the study as they were deemed to be fraudulent. After these cases were identified, potential participants raising red flags drawn from these individuals (i.e., from the same geographic location as noted through Qualtrics IP tracking or blocked IPs, reporting different last names for parent and participant, reporting suspicious email addresses) were screened more closely and barred from participation if deemed to be fraudulent.

Beyond this, the web-based platform may have led to sampling bias, drop out and non-response. While some individuals may have been excluded from this study due to lack of Internet access, we believe this number to be negligible within our population of interest. We affirm that the use of web-based questionnaires for the ASD population may actually promote participation, as it may be less stressful and socially taxing to the individual with ASD compared to a site-based study. However, the study did experience significant decreases in participation between ‘Step 1’ of the study, completion of the consent/assent form, and ‘Step 2’, completing the questionnaires. All participants were emailed individualized links to the password-protected page of the study questionnaires and sent up to five reminder emails. Reminder emails occurred a minimum of 4 days apart and were varied time of day (morning, afternoon and evening). The researcher did
not observe any trends in day or time of day of reminder emails that elicited more participants to complete the questionnaires. Non-response was uncommon, though present. The researcher elected to not force responses to any question throughout the study to allow participants to engage and respond as freely as possible. No efforts were made to correct for non-response in analysis, as it was not substantial enough to warrant for any given analysis.

As a result of slow recruitment and time constraints, the initial goal of 50 participants per group (AS versus NT) was not met. Ultimately, the study was able to recruit 48 Neurotypical and 34 ASD parent-participant dyads. Subsequent power analysis for the oneway ANOVA comparing AAM by group in Manuscript 1, which targeted the primary aim of the study, revealed that the analysis was just shy of the 80% standard, at 77% power. As the overarching goal for the Facing Puberty Study was primarily to describe menses for females with ASD, the researchers feel that this does not impact the strength or importance of the findings observed in the study.

**Summary**

The Facing Puberty Study observed earlier age at menarche for females from multiplex ASD families compared to Neurotypical peers. Parents and daughters from both ASD and NT groups were highly congruent in their reports of age at menarche. Earlier age at menarche may increase risk for a myriad of health concerns across the lifespan, including obesity (Freedman et al., 2003; Okasha et al., 2001), social anxiety and depression in adolescence (Joinson et al., 2011; Kaltiala-Heino et al., 2003; Mendle et al., 2007; Stice et al., 2001), breast cancer (Collaborative Group on Hormonal Factors
in Breast Cancer., 2012; Petridou et al., 1996; Stoll et al., 1994), Type 2 diabetes (He et al., 2010), and cardiovascular disease (Feng et al., 2008; Lakshman et al., 2009). Given the increased prevalence of several of these health concerns already observed for individuals with ASD, notably obesity (Curtin et al., 2014; Egan et al., 2013), anxiety and depression (Buck et al., 2014; Stacy et al., 2014), providers working with these young women should include assessment of age at menarche in their care. No significant differences in menstrual presentation or menstrual symptoms were observed between groups. More females with ASD reported experiencing symptoms at the time of menses, whereas NT females reported experiencing both pre-menstrual and menstrual symptoms. For females with ASD, behavioral, emotional, and dysmenorrheal symptoms posed greater burden compared to physical symptoms. Parents of Neurotypical daughters followed a trend of reporting fewer menstrual symptoms, whereas parents of daughters with ASD reported more pre-menstrual, dysmenorrheal and emotional menstrual symptoms than their daughters. The experience of puberty varied substantially, however several key themes were identified that were unique to families with a daughter on the Autism Spectrum: preparations for puberty, physical experience of menses, speed bumps on the road through puberty, managing the everyday, and looking to the future, as well as reflective advice.

**Future Directions**

The complex needs of females with ASD calls for a multi- and inter-disciplinary approach, combining bench, descriptive, clinical and intervention research to maximize the health and well-being of these women and their families. Their health status,
including women’s health issues, across the lifespan has yet to be fully documented and would add considerably to the literature. For puberty specifically, following a large group of females with ASD across the pubertal years would elucidate a richer understanding of how this population progresses through this key phase of life and their unique needs at different stages of puberty. Future research should also look to female siblings and mothers of individuals with ASD in addition to a Neurotypical comparison group, as these populations represent the ‘Broader Autism Phenotype’ and may shed light on ASD as a spectrum disorder, as well as women’s health concerns for females with ASD. Additionally, measures of sex steroids across puberty and the menstrual cycle may help to establish the cause of increased rates of gynecologic disorders like polycystic ovarian syndrome and hirsutism in females with ASD. There is much yet to uncover within this growing field and research stands to impart substantial benefits to the care and health of females with Autism Spectrum Disorder.
APPENDICES
## Appendix A. Instruments for Data Collection.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Time</th>
<th>Description</th>
<th>Use in Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Questionnaire for Parents</td>
<td>5 min</td>
<td>A 23-item questionnaire to address the socio-demographics of the parent, as well as relevant diagnosis of the daughter.</td>
<td>Assess relevant socio-demographic and diagnostic variables.</td>
</tr>
<tr>
<td>Demographic Questionnaire for Participants</td>
<td>5 min</td>
<td>An 8-item questionnaire on the socio-demographic variables of the participant.</td>
<td>Assess relevant socio-demographic and diagnostic variables.</td>
</tr>
<tr>
<td>Menstrual Disorders of Teenagers (MDOT) Questionnaire, Modified</td>
<td>20 min</td>
<td>This 7-section questionnaire assesses onset, regularity, duration, symptoms of menses and impact on daily activities. The questionnaire will be modified to remove questions on sexuality, as well as add additional questions on menstrual symptoms.</td>
<td>Assess characteristics of menses, and presence and severity of menstrual symptoms.</td>
</tr>
<tr>
<td>Dietary Screener Questionnaire (DSQ)</td>
<td>10 min</td>
<td>A 26-item parent-report assessing consumption of major food types over the past month.</td>
<td>Evaluate level of nutrition.</td>
</tr>
<tr>
<td>Physical Activity Questionnaire, Adolescent Version</td>
<td>10 min</td>
<td>This questionnaire, tailored to children 14-19 years, assesses general levels of activity by parent-report of various activities in the past 7 days.</td>
<td>Evaluate level of physical activity.</td>
</tr>
<tr>
<td>Screen for Child Anxiety Related Disorders</td>
<td>15 min</td>
<td>This 41 item questionnaires assess anxiety symptoms in children 8 to 18 years through self- or parent-report.</td>
<td>Evaluate presence of symptoms related to anxiety disorder.</td>
</tr>
<tr>
<td>Interview Guide</td>
<td>30-60 min</td>
<td>A semi-structured interview question bank, comprised of 14 questions, to initiate conversation with individuals and their families regarding the experience of puberty for females with ASD.</td>
<td>Explore the experience of puberty for daughters with ASD and their parents.</td>
</tr>
</tbody>
</table>
### Appendix B. Summary of Variables. (Primary variables of interest highlighted)

<table>
<thead>
<tr>
<th>Concept</th>
<th>Associated Variable</th>
<th>Type of Variable</th>
<th>Operational Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Continuous</td>
<td>Age in years and months.</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Dichotomous</td>
<td>Participant or parents reported gender.</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td>Categorical</td>
<td>Participant or parents reported race.</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td>Categorical</td>
<td>Participant or parents reported ethnicity.</td>
<td></td>
</tr>
<tr>
<td>Marital_Status</td>
<td>Categorical</td>
<td>Parents reported marital status</td>
<td></td>
</tr>
<tr>
<td>Level_Schooling</td>
<td>Ordinal</td>
<td>Parents reported highest completed level of education.</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>Categorical</td>
<td>Participant or parents primary language.</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>Ordinal</td>
<td>Family income.</td>
<td></td>
</tr>
<tr>
<td>ASD_Dx</td>
<td>Dichotomous</td>
<td>Presence of ASD diagnosis.</td>
<td></td>
</tr>
<tr>
<td>Age_ASD_Dx</td>
<td>Continuous</td>
<td>Age in months at ASD diagnosis.</td>
<td></td>
</tr>
<tr>
<td>Co_Morbidities</td>
<td>Categorical</td>
<td>Presence of other medical conditions.</td>
<td></td>
</tr>
<tr>
<td><strong>Diagnoses</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Medications</strong></td>
<td>Prescription</td>
<td>Categorical</td>
<td>Use of prescription medications in participant.</td>
</tr>
<tr>
<td></td>
<td>Non-Prescription</td>
<td>Categorical</td>
<td>Use of non-prescription medications in participant.</td>
</tr>
<tr>
<td>Birth Control</td>
<td>Dichotomous</td>
<td>Use of birth control in participant.</td>
<td></td>
</tr>
<tr>
<td><strong>Age at Menarche</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAM</td>
<td>Continuous</td>
<td>Age in years and months at which a female has her first menstrual bleeding.</td>
<td></td>
</tr>
<tr>
<td><strong>Period Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regularity</td>
<td>Dichotomous</td>
<td>Self-report of regularity of cycle.</td>
<td></td>
</tr>
<tr>
<td>Cycle_Length</td>
<td>Continuous</td>
<td>Number of days from the first day of bleeding at one period, to the first day of bleeding at the next.</td>
<td></td>
</tr>
<tr>
<td>Clotting</td>
<td>Dichotomous</td>
<td>Presence of blood clots during a period.</td>
<td></td>
</tr>
<tr>
<td>Spotting</td>
<td>Dichotomous</td>
<td>Presence of blood on underpants</td>
<td></td>
</tr>
</tbody>
</table>
between periods (after bleeding from one period has ended, before the next period has begun).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miss_School</td>
<td>Dichotomous</td>
<td>Any number of school days missed due to issues surrounding a period.</td>
</tr>
<tr>
<td>Period_Pain</td>
<td>Ordinal</td>
<td>Level of pain associated with a period in the past 6 months. (0-10)</td>
</tr>
<tr>
<td>Pain_Medication</td>
<td>Dichotomous</td>
<td>Use of any pain relieving medication associated with a period.</td>
</tr>
<tr>
<td>Medication_Effectiveness</td>
<td>Ordinal</td>
<td>Effectiveness of pain relieving medication at relieving pain associated with a period. (0-10)</td>
</tr>
<tr>
<td>Pre-Menstrual Symptoms</td>
<td>PMS_Summary</td>
<td>Summary score of pre-menstrual symptoms: nausea, bloating, diarrhea, constipation, heartburn, headache, breast tenderness, acne, changes in sleep, changes in appetite, lower back pain, depression, irritability, anxiety, changes in mood, and tearfulness. 0 = No Symptom Burden 0.01 - 0.33 = Low Symptom Burden 0.34 – 0.66 = Medium Symptom Burden 0.67 – 1.00 = High Symptom Burden</td>
</tr>
<tr>
<td>Dysmenorrhea</td>
<td>Dys_Summary</td>
<td>Summary score of menstrual pain symptoms: aching- down legs, aching- outside vagina, pelvic pain-cramping, pelvic pain-stabbing, pelvic pain-aching, pelvic-other, and lower back pain. 0 = No Symptom Burden 0.01 - 0.33 = Low Symptom Burden 0.34 – 0.66 = Medium Symptom Burden</td>
</tr>
<tr>
<td>Physical Menstrual Symptoms</td>
<td>Nausea</td>
<td>Dichotomous</td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>Vomiting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bloating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constipation</td>
<td></td>
<td></td>
</tr>
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<td>Reflux_Heartburn</td>
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<td>Presence of anxiety associated with a period.</td>
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<td>Mood changes or mood swings associated with a period.</td>
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<td>Feeling blue, down or depressed associated with a period.</td>
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<td>Impact on Lifestyle</td>
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Symptom Burden

\[0.67 - 1.00 = \text{High Symptom Burden}\]
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unwell from one’s period interferes with one’s lifestyle.

Knowledge of polycystic ovarian syndrome.

Knowledge of endometriosis.

Knowledge of pelvic inflammatory disease.

Presence of polycystic ovarian syndrome in any first (self, mother or sister) degree relative

Presence of endometriosis in any first degree family member.

Presence of pelvic inflammatory disease in any first degree family member.

Presence of fibrocystic breasts in any first degree family member.

Predicted fiber (gm) per day

Predicted calcium (mg) per day

Predicted added sugars (tsp) per day

Predicted ounce equivalents of whole grains per day

Predicted cup equivalents of dairy per day

Predicted cup equivalents of fruits and vegetables (including legumes) per day

Level of activity. A score of 1 indicates low physical activity, a score of 5 indicates high physical activity.

Indicated the overall extend of anxiety symptoms.

Range = 0-82
Score ≥ 25 indicates presence of anxiety
Appendix C. Demographic Questionnaire for Parents

Please answer the following questions to the best of your ability. You will be asked some questions about yourself, and some questions about your daughter with ASD (who will be referred to as the 'daughter', regardless of your relationship to her).

1. How are you related to the young woman with ASD?
   a. Mother
   b. Father
   c. Sibling- Sister
   d. Sibling – Brother
   e. Caretaker/Legal Guardian
   f. Grandparent

2. What is your date of birth?

3. Please specify your race (Select all that apply).
   a. American Indian/Alaska Native
   b. Asian
   c. Native Hawaiian or Other Pacific Islander
   d. Black or African American
   e. White
   f. Other

4. Please specify your ethnicity.
   a. Hispanic or Latino
   b. NOT Hispanic or Latino
   c. Other

5. What is your gender?
   a. Female
   b. Male
   c. Other

6. What is your height (in feet and inches)?

7. What is your weight (in lbs)?

8. What is your primary language?
   a. English
   b. Spanish
   c. German
   d. French
   e. Other

9. What is your marital status?
   a. Single, never married
   b. Married
   c. Widowed
   d. Divorced
   e. Separated
   f. Long term partner
10. What is the highest level of schooling you have completed?
   a. None
   b. Kindergarten through 8th grade
   c. Some high school
   d. High school graduate or GED
   e. Some college courses, no degree
   f. Associate's degree
   g. Bachelor's degree
   h. Master's degree
   i. Professional degree (MD, JD)
   j. Doctoral degree

11. What is your family's annual income?
   a. Less than $20,000
   b. $20,000 - $40,000
   c. $40,000 - $60,000
   d. $60,000 - $80,000
   e. $80,000 - $100,000
   f. $100,000- $150,000
   g. More than $150,000
   h. Prefer not to say

Please answer the following questions about your daughter to the best of your ability.

12. What diagnosis of Autism Spectrum Disorder was your daughter given?
   a. No diagnosis
   b. Autism
   c. PDD-NOS
   d. Asperger's Syndrome
   e. Autism Spectrum Disorder
   f. I don't know

13. At what age (in months) was your daughter diagnosed with an ASD?

14. What type of classroom is she in at school?
   a. She is home schooled
   b. Special Education classroom
   c. Inclusion classroom
   d. Typical classroom
   e. I don't know
   f. Other

15. Does your daughter take any of the following non-prescription medications?
   a. Advil / ibuprofen
   b. Aleve / naproxen
   c. Bayer / aspirin
16. Does your daughter take any prescription medication for the following conditions or reasons?
   a. ADHD
   b. Allergies
   c. Asthma
   d. Bladder control problems
   e. Birth control
   f. Crohn's disease
   g. Constipation
   h. Depression
   i. Gastric reflux or heartburn
   j. Glaucoma
   k. Hemophilia
   l. High blood pressure
   m. Diabetes (Type I or Type II)
   n. High cholesterol
   o. Inflammatory bowel disease
   p. Migraine headache
   q. Hyperthyroidism or Hypothyroidism
   r. Other

If you are the biological mother of the daughter with ASD, please answer the questions below to the best of your ability.

If you are not your daughter's biological mother, or do not recall your pregnancy with your daughter with ASD, please skip the following questions and move on to the next section.

17. At what age (in years, months if you recall) did you start your period?
18. How much weight (in lbs) did you gain while pregnant with your daughter?
19. Did you have preeclampsia while pregnant with your daughter?
20. Was your daughter born prematurely? If so, how many weeks was she born at?
21. Has anyone in your family been diagnosed with an Autism Spectrum Disorder (Autism, Asperger's Syndrome, PDD-NOS)?
   a. No
   b. Yes, my daughter (not participating)
   c. Yes, my son

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d. Yes, myself
e. Yes, my partner
f. Yes, a parent or sibling
g. Yes, a cousin, aunt/uncle, or niece/nephew
h. Yes, Other
i. I don’t know
Appendix D. Demographic Questionnaire for Daughter Participants

You will be asked some questions about yourself, please answer to the best of your ability.

1. What is your date of birth?
2. What is your age (in years)?
3. What is your race?
   a. American Indian/Alaska Native
   b. Asian
   c. Native Hawaiian or Other Pacific Islander
   d. Black or African American
   e. White
   f. Other
4. What is your ethnicity?
   a. Hispanic or Latino
   b. NOT Hispanic or Latino
   c. Other
5. What is your gender?
   a. Female
   b. Male
   c. Other
6. What is your height (in feet and inches)?
7. What is your weight (in lbs)?
8. What is your primary language?
   a. English
   b. Spanish
   c. German
   d. French
   e. Other
9. What grade are you in school?
   a. Kindergarten through 4th grade
   b. 5th through 8th grade
   c. 9th through 12th grade
   d. I am home schooled
   e. College
Appendix E. Modified Parker-Sneddon Menstrual Disorders of Teenagers Questionnaire

Example below is the parent version, participation version is identical with modifications for first person language.

Section 1. General Information.

1. What is your daughter's date of birth (MM/DD/YY)?
2. When did your daughter start menstruating (MM/DD/YY)?

Section 2. About her usual periods. Please answer these statements about your daughter's periods to the best of your ability.

3. Does your daughter have periods?
   a. Yes
   b. No
   c. If not, please explain.
4. Over the past 12 months, her periods have been:
   a. Regular
   b. Irregular
   c. I don't know
5. What is the usual number of days from the first day of bleeding at one period to the first day of bleeding at the next?
6. How many days does she bleed?
7. (Questions 8-17 Modifiable to Length of Flow)
8. On the first day of her period, how heavy is her bleeding?
   a. Light
   b. Medium
   c. Heavy
9. On the second day of her period, how heavy is her bleeding?
   a. Light
   b. Medium
   c. Heavy
10. On the third day of her period, how heavy is her bleeding?
    a. Light
    b. Medium
    c. Heavy
11. On the fourth day of her period, how heavy is her bleeding?
    a. Light
    b. Medium
    c. Heavy
12. On the fifth day of her period, how heavy is her bleeding?
    a. Light
    b. Medium
    c. Heavy
13. On the sixth day of her period, how heavy is her bleeding?
   a. Light
   b. Medium
   c. Heavy
14. On the seventh day of her period, how heavy is her bleeding?
   a. Light
   b. Medium
   c. Heavy
15. On the eighth day of her period, how heavy is her bleeding?
   a. Light
   b. Medium
   c. Heavy
16. On the ninth day of her period, how heavy is her bleeding?
   a. Light
   b. Medium
   c. Heavy
17. On the tenth day of her period, how heavy is her bleeding?
   a. Light
   b. Medium
   c. Heavy
18. Does her bleeding contain clots?
   a. Yes
   b. No
19. If yes, how often does it contain clots?
   a. Sometimes
   b. Most of the time
   c. All the time
20. Do you ever notice spots of blood on her underpants?
   a. Just before a period
   b. In between periods
   c. During periods
   d. Never
21. Does she ever miss school because of her periods?
   a. No
   b. Yes, every period
   c. Yes, some periods
   d. I don’t know
22. If yes, how many days of her period does she usually stay home for?
23. What is it about her period that causes her to miss school?
   a. Too painful
   b. Blood flow too heavy
   c. Nausea or vomiting
   d. Other: ____________
24. Have her period symptoms worsened over the past 12 months?
25. Please rate her period pain over the past 12 months? (0 being no pain, 10 being the worst pain)

26. Does she take medication for her period pain?
   a. No
   b. Yes
   c. I don’t know
   d. Not applicable

27. If so, what type of medication does she usually take?
   a. Naproxen
   b. Advil
   c. Aspirin
   d. Ibuprofen
   e. Other: ___________

28. How effective is it at relieving her pain? (0 being not effective, 10 being highly effective)

29. Does she use hormonal birth control?
   a. Yes
   b. No

30. If ‘yes’, what type of birth control does she use?
   a. Oral birth control (‘The Pill’)
   b. Intruterine device (IUD)
   c. Vaginal ring (NuvaRing)
   d. Hormonal patch (OrthoEvra)
   e. Hormonal implant (Implanon, Norplant)
   f. Hormonal injection (Depo-Provera)

31. Why does she use hormonal birth control?
   a. To regulate her periods
   b. To decrease her menstrual symptoms
   c. To cause her periods to happen less frequently
   d. Other: _____

Section 3. Over the past 12 months, has your daughter experienced any of the following in relation to her monthly period?

Please answer these questions to the best of your ability. If you do not know the answer, please select 'I don't know'. Please do not ask your daughter.

Answers: Doesn't apply to her, No/Never, Just before a period, At the time of the period, Any time of the month, All the time, Sometimes, I don't know

1. Nausea
2. Vomiting
3. Bloating
4. Diarrhea
5. Constipation
6. Indigestion, reflux, or heartburn
7. Changes in appetite
8. Changes in sleep
9. Aching outside her vagina
10. Aching down her legs
11. Pelvic pain - aching
12. Pelvic pain - cramping
13. Pelvic pain - stabbing
14. Pelvic pain - other
15. Lower back pain
16. Pain when urinating
17. Pain when emptying bowel
18. Headaches
19. Thrush (itchy and sore around and outside the vagina)
20. Dizziness, fainting or passing out
21. Feeling down or depressed
22. Breast tenderness
23. Cyclical acne
24. Social withdrawal
25. Decreased interest
26. Concentration problems
27. Anxiety
28. Moodiness
29. Tearfulness or increased sensitivity to rejection

Section 4. Does her period affect her lifestyle? Please rate from 0 to 10, with 0 meaning no interference, and 10 meaning major interference, N/A = not applicable (to her).

Please answer these questions to the best of your ability. If you do not know the answer, please select 'I don't know'. Please do not ask your daughter.

1. Attending school
2. Completing school work
3. Casual paid work
4. Social activities
5. Relationships with family
6. Relationships with friends
7. Relationship with a partner
8. Sports or exercise
9. Does the above interference with lifestyle occur with:
   a. Some periods
   b. Most periods
   c. All periods
   d. Not applicable to her

What is it about her period that interferes with her life? 0 = no interference, 10 = major interference, N/A = not applicable (to her).

Please answer these questions to the best of your ability. If you do not know the answer, please select 'I don't know'. Please do not ask your daughter.

1. Pain
2. Heavy blood flow
3. Tiredness / fatigue
4. Moods
5. Generally feeling unwell
6. Other: ___________
7. Does the above interference with lifestyle occur with:
   a. Some periods
   b. Most periods
   c. All periods
   d. Not applicable to her
   e. I don't know

Section 5. The following is a list of statements related to periods. Please select the answer that best represents your beliefs of your daughter’s period for each statement. N/A = not applicable (to her).

Please answer these questions to the best of your ability. If you do not know the answer, please select 'I don't know'. Please do not ask your daughter.

Answers: True, False, I don’t know, Not applicable to her

1. She usually has a period every month.
2. She has never missed a period.
3. She has problems with her periods.
4. She has had tests because things weren't right with her period.
5. She has a period problem that has a name.
6. She is on the pill.
7. She is on the pill to help period pain.
8. She has never taken the pill.
9. Her periods don't worry me too much.
10. Her periods worry me a lot.
11. Her periods are 'normal' most of the time.
12. Sometimes I think there is something 'wrong' with her periods.
13. I am sure there is something 'wrong' with her periods.
14. She has never used a tampon.
15. She has tried to use a tampon but couldn't get it in.
16. She is not interested in using a tampon.
17. She can insert a tampon but it is too uncomfortable.
18. She only uses tampons.
19. She only uses pads (sanitary napkins).
20. She has difficulties using pads.
21. She is not interested in using pads.
22. She can use a pad, but it is too uncomfortable.
23. She uses pads and tampons.
24. She often gets lots of pimples on her face.
25. She often gets lots of pimples on her back.
26. She often gets lots of pimples on her chest.
27. She has more hair than usual growing on her body.
28. She has had a blood test for her period pain.
29. She has had an ultrasound to look for causes of her period pain.
30. She has had an operation to look for causes of her period pain.
31. She talks to her friends about her period.
32. She talks to me about her period.
33. She talks to her doctor about her period.
34. She talks to a specialist doctor about her period.
35. She talks to a naturopath/herbalist/acupuncturist about her period.
36. She is grumpy before or during her periods.
37. She is grumpy all the time.
38. She gets teary before or during a period.
39. She feels overwhelmed and not able to cope before or during a period.
40. She often wants to withdraw or hide when she has her period.
41. Her periods don't affect her moods.

Section 6. Please list any allergies or intolerances your daughter has.

1. Medications: ______________
2. Foods: ____________________
3. Other (bee stings, seasonal allergies): ______________

Section 7. Have you ever heard of the following? Please answer these questions about yourself, not your daughter.

1. Polycystic ovarian syndrome / polycystic ovaries.
   a. No
   b. Yes
   c. I don’t know

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2. Endometriosis
   a. No
   b. Yes
   c. I don’t know

3. Pelvic inflammatory disease (PID).
   a. No
   b. Yes
   c. I don’t know

Do you, your mother or sister have any of the following?

1. Period problems
   a. Yes
   b. No
   c. I don't know

2. Severe period pain
   a. Yes
   b. No
   c. I don’t know

3. Polycystic ovarian syndrome / polycystic ovaries
   a. Yes
   b. No
   c. I don't know

4. Endometriosis
   a. Yes
   b. No
   c. I don't know

5. Pelvic inflammatory disease (PID)
   a. Yes
   b. No
   c. I don't know

6. Fibrocystic Breasts
   a. Yes
   b. No
   c. I don’t know

7. Is there anything else that you would like to tell us about you or your daughter's periods, or something that has changed in either of your periods?
Appendix F. Dietary Screening Questionnaire

These questions are about foods your daughter ate or drank during the past month, that is, the past 30 days. When answering, please include meals and snacks at home, at work or school, in restaurants, and anywhere else.

1. During the past month, how often did your daughter eat hot or cold cereals?
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

2. During the past month, what kind of cereal did she usually eat? _________

3. During the past month, how often did your daughter have any milk (either to drink or on cereal)? Include regular milks, chocolate or flavored milks, lactose-free milk, buttermilk. Please DO NOT include soy milk or small amounts of milk in coffee or tea.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2-3 times per day
   j. 4-5 times per day
   k. 6 or more times per day

4. During the past month, what kind of milk did she usually drink? If other, please list.
   a. Whole or regular milk
   b. 2% fat or reduced-fat milk
   c. 1%, 1/2% or low-fat milk
   d. Fat-free, skim or nonfat milk
   e. Soy milk
   f. Other: ______________

5. During the past month, how often did your daughter drink regular soda or pop that contains sugar? Do NOT include diet soda.
   a. Never
   b. 1 time last month
c. 2-3 times last month
d. 1 time per week
e. 2 times per week
f. 3-4 times per week
g. 5-6 times per week
h. 1 time per day
i. 2-3 times per day
j. 4-5 times per day
k. 6 or more times per day

6. During the past month, how often did your daughter drink 100% pure fruit juices, such as orange, mango, apple, grape and pineapple juices? Do NOT include fruit-flavored drinks with added sugar or fruit juice you made at home and added sugar to.
   a. Never
   b. 1 time last month
c. 2-3 times last month
d. 1 time per week
e. 2 times per week
f. 3-4 times per week
g. 5-6 times per week
h. 1 time per day
i. 2-3 times per day
j. 4-5 times per day
k. 6 or more times per day

7. During the past month, how often did your daughter drink coffee or tea that had sugar or honey added to it? Include coffee and tea you sweetened yourself and presweetened tea and coffee drink such as Arizona Iced Tea and Frappuccino. Do NOT include artificially sweetened coffee or diet tea.
   a. Never
   b. 1 time last month
c. 2-3 times last month
d. 1 time per week
e. 2 times per week
f. 3-4 times per week
g. 5-6 times per week
h. 1 time per day
i. 2-3 times per day
j. 4-5 times per day
k. 6 or more times per day

8. During the past month, how often did your daughter drink sweetened fruit drinks, sport or energy drinks, such as Kool-Aid, lemonade, Hi-C, cranberry drink, Gatorade, Red Bull or Vitamin Water? Include fruit juices you made at home and added sugar to. Do NOT include diet drinks or artificially sweetened drinks.
   a. Never
9. During the past month, how often did your daughter eat fruit? Include fresh, frozen or canned fruits. Do NOT include juices.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2-3 times per day
   j. 4-5 times per day
   k. 6 or more times per day

10. During the past month, how often did your daughter eat a green leafy or lettuce salad, with or without other vegetables?
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

11. During the past month, how often did your daughter eat any kind of fried potatoes, including french fries, home fries, or has brown potatoes.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

12. During the past month, how often did your daughter eat any other kind of potatoes,
such as baked, boiled, mashed potatoes, sweet potatoes, or potato salad?
  a. Never
  b. 1 time last month
  c. 2-3 times last month
  d. 1 time per week
  e. 2 times per week
  f. 3-4 times per week
  g. 5-6 times per week
  h. 1 time per day
  i. 2 or more times per day

13. During the past month, how often did your daughter eat refried beans, baked beans, beans in soup, pork and beans or any other type of cooked dried beans? Do NOT include green beans.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

14. During the past month, how often did your daughter eat brown rice or other cooked whole grains, such as bulgur, cracked wheat, or millet? Do NOT include white rice.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

15. During the past month, not including what you just told us about green salads, potatoes, and cooked beans, how often did your daughter eat other vegetables?
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
i.  2 or more times per day

16. During the past month, how often did your daughter have Mexican-style salsa made with tomato?
   a.  Never
   b.  1 time last month
   c.  2-3 times last month
   d.  1 time per week
   e.  2 times per week
   f.  3-4 times per week
   g.  5-6 times per week
   h.  1 time per day
   i.  2 or more times per day

17. During the past month, how often did your daughter eat pizza? Include frozen pizza, fast food pizza and homemade pizza.
   a.  Never
   b.  1 time last month
   c.  2-3 times last month
   d.  1 time per week
   e.  2 times per week
   f.  3-4 times per week
   g.  5-6 times per week
   h.  1 time per day
   i.  2 or more times per day

18. During the past month, how often did your daughter eat any kind of cheese? Include cheese as a snack, cheese on burgers, sandwiches, and cheese in foods such as lasagna, quesadillas, or casseroles. Do NOT include cheese on pizza.
   a.  Never
   b.  1 time last month
   c.  2-3 times last month
   d.  1 time per week
   e.  2 times per week
   f.  3-4 times per week
   g.  5-6 times per week
   h.  1 time per day
   i.  2 or more times per day

19. During the past month, how often did your daughter eat red meat, such as beef, pork, ham or sausage? Do NOT include chicken, turkey or seafood. Include red meat she had in sandwiches, lasagna, stew, and other mixtures. Red meats may also include veal, lamb, and any lunch meats made with these meats.
   a.  Never
   b.  1 time last month
   c.  2-3 times last month
   d.  1 time per week
   e.  2 times per week
20. During the past month, how often did your daughter eat any processed meat, such as bacon, lunch meats, or hot dogs? Include processed meats you had in sandwiches, soups, pizza, casseroles, and other mixtures. Processed meat are those preserved by smoking, curing, or salting, or by the addition of preservative. Examples are: ham, bacon, pastrami, salami, sausages, bratwursts, frankfurters, hot dogs and spam.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

21. During the past month, how often did your daughter eat whole grain bread, including toast, rolls and in sandwiches? Whole grain includes whole wheat, rye, oatmeal, and pumpernickel. Do NOT include white bread.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

22. During the past month, how often did your daughter eat chocolate or any other types of candy? Do NOT include sugar-free candy.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

23. During the past month, how often did your daughter eat doughnuts, sweet rolls, Danish, muffins, pan dulce, or pop-tarts? Do NOT include sugar-free items.
24. During the past month, how often did your daughter eat cookies, cake, pie, or brownies? Do NOT include sugar-free kinds.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

25. During the past month, how often did your daughter eat ice cream or other frozen desserts? Do NOT include sugar-free kinds.
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day

26. During the past month, how often did your daughter eat popcorn?
   a. Never
   b. 1 time last month
   c. 2-3 times last month
   d. 1 time per week
   e. 2 times per week
   f. 3-4 times per week
   g. 5-6 times per week
   h. 1 time per day
   i. 2 or more times per day
Appendix G. Physical Activity Questionnaire – Adolescent Version

We are trying to find out about your level of physical activity from the last 7 days (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Remember:

There are no right and wrong answers — this is not a test. Please answer all the questions as honestly and accurately as you can — this is very important.

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row.)

   Answers: No, 1-2, 3-4, 5-6, 7 times or more
   a. Skipping
   b. Rowing/canoeing
   c. In-line skating
   d. Tag
   e. Walking for exercise
   f. Bicycling
   g. Jogging or running
   h. Aerobics
   i. Swimming
   j. Baseball, softball
   k. Dance
   l. Football
   m. Badminton
   n. Skateboarding
   o. Soccer
   p. Street hockey
   q. Volleyball
   r. Floor hockey
   s. Basketball
   t. Ice skating
   u. Cross-country skiing
   v. Ice hockey/ringette
   w. Other: __________________

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

   a. I don’t do PE
   b. Hardly ever
   c. Sometimes
   d. Quite often
   e. Always

3. In the last 7 days, what did you normally do at lunch (besides eating lunch)?
(Check one only.)
  a. Sat down (talking, reading, doing schoolwork)
  b. Stood around or walked around
  c. Ran or played a little bit
  d. Ran around and played quite a bit
  e. Ran and played hard most of the time

4. In the last 7 days, on how many days right after school, did you do sports, dance, or play games in which you were very active? (Check one only.)
   a. None
   b. 1 time last week
   c. 2 or 3 times last week
   d. 4 times last week
   e. 5 times last week

5. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only.)
   a. None
   b. 1 time last week
   c. 2 or 3 times last week
   d. 4 or 5 last week
   e. 6 or 7 times last week

6. On the last weekend, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)
   a. None
   b. 1 time
   c. 2 — 3 times
   d. 4 — 5 times
   e. 6 or more times

7. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.
   a. All or most of my free time was spent doing things that involve little physical effort
   b. I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics)
   c. I often (3 — 4 times last week) did physical things in my free time
   d. I quite often (5 — 6 times last week) did physical things in my free time
   e. I very often (7 or more times last week) did physical things in my free time

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week. Answers: None, Little bit, Medium, Often, Very often
   a. Monday
   b. Tuesday
   c. Wednesday


d. Thursday  
e. Friday  
f. Saturday  
g. Sunday  
9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)  
a. Yes  
b. No  
c. If Yes, what prevented you? ___________________
Appendix H. Screen for Child Anxiety Related Disorders (SCARED)

Example below is the parent version, participation version is identical with modifications for first person language.

Below is a list of sentences that describe how people feel. Read each phrase and decide if it is "Not True or Hardly Ever True" or "Somewhat True or Sometimes True" or "Very True or Often True" for your child. Then, for each statement, fill in the circle that corresponds to the response that seems to describe your child for the last 3 months. Please respond to all statements as well as you can, even if some do not seem to concern your child.

1. When my child feels frightened, it is hard for him/her to breathe.
2. My child gets headaches when he/she am at school.
3. My child doesn’t like to be with people he/she doesn’t know well.
4. My child gets scared if he/she sleeps away from home.
5. My child worries about other people liking him/her.
6. When my child gets frightened, he/she feels like passing out.
7. My child is nervous.
8. My child follows me wherever I go.
9. People tell me that my child looks nervous.
10. My child feels nervous with people he/she doesn’t know well.
11. My child gets stomachaches at school.
12. When my child gets frightened, he/she feels like he/she is going crazy.
14. My child worries about being as good as other kids.
15. When my child gets frightened, he/she feels like things are not real.
16. My child has nightmares about something bad happening to his/her parents.
17. My child worries about going to school.
18. When my child gets frightened, his/her heart beats fast.
19. He/she child gets shaky.
20. My child has nightmares about something bad happening to him/her.
21. My child worries about things working out for him/her.
22. When my child gets frightened, he/she sweats a lot.
23. My child is a worrier.
24. My child gets really frightened for no reason at all.
25. My child is afraid to be alone in the house.
26. It is hard for my child to talk with people he/she doesn’t know well.
27. When my child gets frightened, he/she feels like he/she is choking.
28. People tell me that my child worries too much.
29. My child doesn’t like to be away from his/her family.
30. My child is afraid of having anxiety (or panic) attacks.
31. My child worries that something bad might happen to his/her parents.
32. My child feels shy with people he/she doesn’t know well.
33. My child worries about what is going to happen in the future.
34. When my child gets frightened, he/she feels like throwing up.
35. My child worries about how well he/she does things.
36. My child is scared to go to school.
37. My child worries about things that have already happened.
38. When my child gets frightened, he/she feels dizzy.
39. My child feels nervous when he/she is with other children or adults and he/she has to do something while they watch him/her (for example: read aloud, speak, play a game, play a sport.)
40. My child feels nervous when he/she is going to parties, dances, or any place where there will be people that he/she doesn’t know well.
41. My child is shy.
Appendix I. Semi-Structured Interview Guide for Parent

Word Association: What comes to mind when you think of:
- Puberty for your daughter
- Your daughter’s periods

Thinking back to the day your daughter got her first period, how did she react to getting her period?

How does (your daughter) manage her periods now?

Did you and (your daughter) talk about puberty and periods before she got her period? How do you talk about them now?

What resources have you used to prepare yourself and/or your daughter for puberty?

How did you think about puberty or periods before she entered? How about now?

Does she talk to friends/siblings about ‘growing up’?

Some of the girls in the study reported feeling a lot or very little pain in relation to their periods. Do you feel your daughter experiences an atypical amount of pain related to her periods compared to her peers? What does your daughter do (or what does your family do) to help her cope with her period pain?

Does your daughter have any sensory issues? Has it influenced how she manages her periods?

How do you feel when you think about your daughter growing up?

What would you like to tell other mothers whose daughters with ASD who are entering puberty/will start their periods soon?

What would you have done the same or differently in helping your daughter prepare for getting her period?

Anything you’d like to tell other families with girls with Autism who are going through puberty?

Wrap: Thank you so much for your time. Is there anything else that you’d like to share? Is there anything want us to know?
Appendix J. Semi-Structured Interview Guide for Participant

Word Association: I’d like you to tell me what words that come to mind when you think about…
- Puberty
- Your period

Okay. You shared the word __________ I’d like to talk more about that. Why do you say ______ when we talk about ________? Does it have meaning for you?

How does your body feel when you have your period?

How do you feel emotionally when you have your period?

What do you do to get ready for your period? Does it work?

Do you always know when your period is coming? Does it ever surprise you?

Do you remember the first time you got your period? Can you tell me about it?

Have you learned about bodies or periods at school? Do you talk about bodies or periods with your friends? Your sisters? What do you talk about?

Are you taking any medication that affects your period?

Do you track your period? How?

If you have a friend about to get her period for the first time, what would you tell her to help her get ready?

Is there anything you’d like to tell other girls with Autism who are going through puberty?

Have you ever missed out on anything you wanted to do because you had your period?

Wrap: Thank you so much for your time. Is there anything else that you’d like to share? Is there anything want us to know?


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