



Quality of life, gastrointestinal symptoms, sleep problems, social support, and social functioning in adults with autism spectrum disorder

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ABSTRACT

Background: The purpose of this study was to investigate the relationship between sleep problems, gastrointestinal symptoms, social functioning, autism traits, and social support on quality of life (QoL) in 107 adults with autism spectrum disorder (ASD).

Method: Questionnaires included the Autism Spectrum Quotient-10 (Adult), Multidimensional Scale of Perceived Social Support, Social Functioning Questionnaire, Pittsburgh Sleep Quality Index, Gastrointestinal Symptom Inventory, and World Health Organization Quality of Life-BREF. **Results:** GI symptoms were a common comorbidity with 86 % of participants presenting with them. Sleep problems were also frequent issues with 89 % of participants being classified as poor sleepers. Greater sleep problems were correlated with poorer QoL in the physical health and environment domains. Specifically, the sleep problem of daytime dysfunction was correlated with poorer QoL in physical health. Daytime dysfunction and sleep duration were correlated with poorer QoL in the environment domain. Better social support was correlated with greater QoL in the psychological, social and environment domains. Poorer social functioning was correlated with poorer QoL in each of the four domains.

Conclusion: This research indicated that GI symptoms and sleep problems are common comorbid conditions in the adult ASD population. This paper expanded upon the existing literature by highlighting unexplored factors influencing QoL in adults with ASD.

What this paper adds?

This paper investigated the frequency of sleep problems, gastrointestinal symptoms, social functioning, autism traits and social support in 107 adults with autism spectrum disorder (ASD). The paper investigated how these variables were associated with quality of life (QoL). It was found that 86 % of participants presented with at least one gastrointestinal (GI) symptom within the previous three months. It was found that 89 % of participants were classified as poor sleepers. Sleep problems were correlated with lower QoL in the domains of physical health and environment. The sleep problem of daytime dysfunction was correlated with poorer QoL in physical health. Daytime dysfunction and sleep duration were correlated with poorer QoL in the environment domain. It was found that social functioning was significantly associated with greater QoL in the psychological, social and environment domains. Better social support

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was correlated with greater QoL in all of the QoL domains. Greater perceived availability of social support from family was significantly associated with higher QoL in the psychological and environment domains. The novel additions that this paper adds are (1) presenting data on the high frequency of GI symptoms in an adult ASD population, (2) presenting data on the high frequency of sleep problems, and (3) inclusion of these physical comorbid conditions in an analysis of correlates of QoL. The novel findings that this paper adds are: (1) GI symptoms and sleep problems are common comorbid conditions in adults with ASD (2) Sleep problems, specifically daytime dysfunction and sleep duration were correlated with poorer QoL, (3) Better social functioning and social support were correlated with greater QoL.

1. Introduction

1.1. Autism spectrum disorder

Individuals with autism spectrum disorder (ASD) show deficits in social communication and restricted, repetitive patterns of behavior ([American Psychiatric Association, 2013](#)). In this study, autism severity is based on the severity of these behaviors. The term ASD is used as the term high-functioning autism spectrum disorder has been identified as a misnomer ([Alvares et al., 2020](#)). Comorbid conditions are common in individuals with ASD including anxiety, attention-deficit/hyperactivity disorder (AD/HD), physical comorbid conditions, and behavior problems ([Devlin, Healy, Leader, & Reed, 2008](#); [Leader & Mannion, 2016b](#); [Mannion & Leader, 2014a](#)).

A meta-analysis by [Zimmerman, Ownsworth, O'Donovan, Roberts, and Gullo \(2018\)](#) based on ASD in adulthood found that severity of ASD symptoms was consistently related to diverse outcomes, including depression, quality of life, loneliness, anxiety, stress, sexual wellbeing, self-esteem, marital satisfaction, and suicidal ideation. In contrast, other studies reported that adults with ASD who were anticipated to have poor adult outcomes as children based on their restricted intellectual or language development were found to lead satisfactory lives ([Persson, 2000](#); [Ruble & Dalrymple, 1996](#)). Given these diverse longitudinal outcomes of individuals with ASD, it is paramount to measure outcomes more comprehensively, including subjective variables such as quality of life (QoL; [Renty & Roeyers, 2006](#); [Ruble & Dalrymple, 1996](#)) and to identify predictors that can be changed by therapeutic intervention ([Kamio, Inada, & Koyama, 2013](#)). In addition, several outcome studies have focused on unidimensional outcomes whereas QoL is a more comprehensive, multidimensional outcome measure ([Renty & Roeyers, 2006](#)).

1.2. Quality of life in ASD

QoL scores measure an individual's wellbeing covering several areas of functioning, such as physical and psychological health, independence levels, social relationships, and individual beliefs ([WHOQOL Group, 1997](#)). The concept of QoL has progressively been applied to people with intellectual disabilities (ID; [Schalock, Verdugo, & Braddock, 2002](#); [Schalock, 2004](#)). However, a small number of studies have examined QoL in adults with ASD in the literature ([Kamio, Inada, & Koyama, 2013](#); [Khanna, Jariwala-Parikh, West-Strum, & Mahabaleshwarkar, 2014](#); [Leader, Grennan, Chen, & Mannion, 2018](#); [Renty & Roeyers, 2006](#)).

[Renty and Roeyers \(2006\)](#) found that perceived social support was correlated with QoL in adults with ASD, however no relationship was found between autism severity and QoL. [Jennes-Coussens, Magill-Evans, and Koning \(2006\)](#), examined the QoL in adult men diagnosed with ASD compared to controls and found lower social and physical health scores among the participants with ASD. Similarly, research by [Kamp-Becker, Schroder, Remschmidt, and Bachmann \(2010\)](#) found lower physical, psychological and social health scores in adults and adolescents with ASD when compared to typically developing controls. Similar to the findings of [Renty and Roeyers \(2006\)](#), they found no relationship between autism severity and QoL. [Kamio et al. \(2013\)](#) investigated QoL and associated factors among adults with ASD in adults in Japan. In line with prior mentioned research, QoL scores in psychosocial and social health were found to be lower among adults with ASD in comparison to the general adult population. In addition, early diagnosis of ASD, mother's support, and the absence of comorbid psychiatric conditions was associated with greater QoL. Presence of comorbid psychiatric illness and aggressive behaviors were associated with poorer QoL.

[Khanna et al. \(2014\)](#) investigated health-related QoL (HRQoL) and associated factors in adults with ASD. HRQoL represents health-related domains that can be influenced and that are responsive to treatments or interventions ([Khanna et al., 2014](#)). [Khanna et al. \(2014\)](#) determined if HRQoL was correlated with the following two measures among adults with ASD: coping and perceived social support from different sources (family, friends, and significant other). Adults with ASD had lower physical and mental HRQoL than adults in the general population ([Khanna et al., 2014](#)). The presence of comorbid mental illness, being divorced or separated, having Asperger Syndrome (AS) over pervasive developmental disorder (PDD) or ASD, less social support from friends, maladaptive coping, low insurance status, not living in a support group, and comorbid physical illness impacted negatively on QoL. [Khanna et al. \(2014\)](#) found that greater social support, and older age affected QoL positively. Higher autism severity scores were associated with greater physical QoL but lower mental QoL ([Khanna et al., 2014](#)).

1.3. QoL in adulthood

While these studies provide information concerning factors related to QoL among adults with ASD, research on QoL itself is limited in the adult ASD population. Studies investigating the relationship between autism severity and QoL reach mixed conclusions underlining the need for further examination. Presence and absence of specific physical conditions and psychological disorders in relation to QoL within the ASD population have not been examined sufficiently despite psychological disorders and physical conditions

being present in this population (Baker & Richdale, 2015; Hofvander et al., 2009; Jokiranta et al., 2014).

1.4. Psychological disorders

Psychological disorders such as depression and anxiety are highly prevalent in the ASD population (Lugnegård, Hallerbäck, & Gillberg, 2011; Hofvander et al., 2009). Research by Hofvander et al. (2009) found that 53 % of adults with ASD, AS, or pervasive developmental disorder-not otherwise specified (PDD-NOS) with normal intelligence had a mood disorder and 50 % had an anxiety disorder. In a Swedish study on adults with ASD, 70 % of adults experienced one major episode of depression, 50 % experienced recurrent depressive episodes, and 50 % had an anxiety disorder (Lugnegård et al., 2011). Comorbid diagnoses of AD/HD appear to be highly prevalent in the adult ASD population. Hofvander et al. (2009) found 43 % of adults with ASD with normal intelligence reported having a comorbid diagnosis of AD/HD. Research with an adolescent sample with ASD found 44 % of the participants had combined AD/HD subtype (Mattila et al., 2010).

1.5. Sleep problems

High rates of physical comorbid conditions such as sleep problems and gastrointestinal symptoms are also prevalent in the ASD population (Mannion & Leader, 2014b). Research on adults with ASD indicates that sleep problems are prevalent in this population (Baker & Richdale, 2015; Hare, Jones, & Evershed, 2006; Matson, Wilkins, & Ancona, 2008; Tani et al., 2005). Research indicates that sleep disturbances persist into adulthood, indicating that they are a lifelong condition in individuals with ASD (Mannion & Leader, 2014c). Previous studies have found increased rates of sleep disturbances, longer sleep onset latencies and poorer sleep efficiency in adults with ASD (Baker & Richdale, 2015; Hare et al., 2006; Limoges, Mottron, Bolduc, Berthiaume, & Godbout, 2005), with insomnia being the most common sleep problem (Tani et al., 2003).

1.6. Gastrointestinal symptoms

Research on prevalence of gastrointestinal symptoms in ASD has found that these are common conditions yet research on adults with ASD is scarce (Leader & Mannion, 2016a). Croen et al. (2015) reported that gastrointestinal disorders were present in 34.7 % in adults with ASD and this was significantly higher than the prevalence rate of 27.47 % for controls. However, one of the limitations of this study was the use of a combined sample of adults diagnosed with different sub-types of ASD were used. The prevalence of gastrointestinal symptoms has been examined in children with ASD in comparison to the neuro-typical siblings (Badalyan & Schwartz, 2011). They found that constipation and fecal incontinence was more prevalent in children with ASD than in their siblings.

1.7. Current study

Factors influencing QoL for individuals with ASD are not yet fully understood (Grennan, Mannion, & Leader, 2018; Jennes-Coussens et al., 2006). The relationship between comorbid conditions such as sleep problems and gastrointestinal symptoms and QoL has not yet been investigated in adults with ASD. The present study examines for the first time, gastrointestinal symptoms and sleep problems as variables potentially correlated with QoL in adults with ASD. The purpose of this study is also to expand on previous research by determining the associations of social functioning, autism traits, and social support on each QoL domain.

2. Method

2.1. Participants

Participants were 107 adults with a diagnosis of ASD and were recruited through online support groups and organizations for individuals with ASD. The mean age was 38.04 years ($SD = 12.04$) ranging from 18 to 69 years. Participants were 70.1 % female ($n = 75$) and 29.9 % male ($n = 32$). Diagnoses were provided by licenced psychologists independent of the study. Individuals completed the Autism Spectrum Quotient (AQ-10) as a screening tool. Participants were omitted from the analyses if they did not meet the cut-off for the AQ-10.

2.2. Procedure

Individuals over the age of 18 with an ASD diagnosis were invited to participate in this study. Participants were made aware of the study through support groups for individuals with ASD. There were no inclusion/exclusion criteria used before a support group was included in the study, other than the support group needed to be for adults with ASD. Invitations to take part in the study were distributed through online support groups for individuals with ASD. If participants wished to participate in the study, they were provided with a participant information form and a consent form to complete. Once consent was obtained, participants were provided with the battery of the below questionnaires to complete in their own time. Rating scales were completed by participants independently according to the instructions which were printed on the top of each questionnaire.

2.3. Measures

2.3.1. Demographic information

A self-constructed questionnaire provided information on participant's age, gender, employment status, and information on current occupation where applicable. Presence or absence of the following comorbid psychological disorders and physical or medical conditions; major depressive disorder, generalized anxiety disorder, mixed anxiety depressive disorder, post-traumatic stress disorder (PTSD), AD/HD, obsessive compulsive disorder, bipolar disorder, sight impairment, hearing impairment, autoimmune conditions, diabetes, were reported, as well as any other current comorbid diagnosis.

2.3.2. Autism Spectrum Quotient-10 items (AQ-10; Adult)

The AQ-10 (Allison, Auyeung, & Baron-Cohen, 2012) was used to measure the severity of autism traits. The AQ-10 is a short form of the 50-item AQ (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). The AQ-10 assesses autistic traits in the following five domains: social skill limitations, attention to detail, difficulty in switching attention, imagination limitations, and communication (Allison et al., 2012). All 10 items of the AQ-10 are scored on a four-point Likert scale ("definitely agree" (1) - "definitely disagree" (4)). Scores on each item were totalled to provide the total score. The AQ-10 has high reliability and validity (Allison et al., 2012).

2.3.3. Multidimensional Scale of Perceived Social Support (MSPSS)

The MSPSS was employed to measure the perceived availability and adequacy of social support (Zimet, Dahlem, Zimet, & Farley, 1988). The MSPSS consists of 12 items and assesses social support from three sources – family (four items), friends (four items), and significant other (four items). Each item of MSPSS is assessed on a seven-point Likert scale from "very strongly agree" (1) to "very strongly disagree" (7). The three subscales are summed to provide a total score. A greater score on the subscales and total scores indicate a greater perceived availability and adequacy of social support. The MSPSS showed to be psychometrically sound in diverse samples, as well as having good internal reliability and test-retest reliability, and robust factorial validity (Cecil, Stanley, Carrion, & Swann, 1995; Zimet et al., 1988).

2.3.4. Social Functioning Questionnaire (SFQ)

The SFQ (Tyrer et al., 2005) was used to assess social functioning among the participants. The SFQ is a short form of the Social Functioning Schedule (Tyrer et al., 2005) and measures an individual's perception of social functioning. The SFQ is an eight-item scale that assess social functioning in the following domains: work and home tasks, financial concerns, familial relationships, sexual activities, social contacts, and spare time activities. The respondent chooses one out of four possible answers for each item. The scores of the eight items are summed to provide a total score. The total score can range from 0 to 24. Scores greater than ten indicate poor social functioning. The SFQ has good reliability and construct validity (Remington & Tyrer, 1979). Additionally, the SFQ has strong test-retest and inter-rater reliability (Tyrer et al., 2005).

2.3.5. Pittsburgh Sleep Quality Index (PSQI)

The PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a retrospective, self-report questionnaire designed to measure the quality and patterns of sleep in adults over the past month. The PSQI has 19 self-rated items and five items rated by a bed partner or a roommate. The 19-item self-report items are combined to form seven "component" scores, one per each subscale: Subjective Sleep Quality, Sleep Latency, Sleep Duration, Habitual Sleep Efficiency, Sleep Disturbances, Use of Sleep Medication, and Daytime Dysfunction. The following statement is an example of what participants were asked in relation to daytime dysfunction: "During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?". Sleep duration sample item included "During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)" Each score has a range of 0–3 points and in all cases, a score of "0" indicates no difficulty, while a score of "3" indicates severe difficulty. The seven component scores are then added to yield one "global" score with a range 0–21 points, "0" indicating no difficulty and "21" indicating severe difficulties in all areas. The PSQI has high internal reliability ($\alpha = 0.83$) (Buysse et al., 1989).

2.3.6. Gastrointestinal Symptom Inventory

The Gastrointestinal Symptom Inventory (Autism Treatment Network, 2005) was used to assess the presence of gastrointestinal symptoms. The Gastrointestinal Symptom Inventory is a 35-item parent-report questionnaire developed by the Autism Treatment Network (ATN). Symptoms assessed include: Abdominal pain, Nausea, Bloating, Diarrhea and Other GI symptoms. A summary variable was constructed to reflect the total number of chronic GI problems experienced. It has been implemented in previous published research with children and adolescents with ASD (Leader, Francis, Mannion, & Chen, 2018; Mannion & Leader, 2013, 2016; Mazefsky, Schreiber, Olino, & Minshew, 2014; Williams, Christofi, Clemmons, Rosenberg, & Fuchs, 2012; Williams, Fuchs, Furuta, Marcon, & Coury, 2010). The questionnaire in this study was adjusted to be a self-report questionnaire. For example, "Has your child experienced nausea in the past 3 months?" was changed to "Have you experienced nausea in the past 3 months?". The questionnaire is scored dichotomously; indicating the presence or absence of symptoms.

2.3.7. World Health Organization-Quality of Life (WHOQOL-BREF)

The WHOQOL-BREF (WHOQOL Group, 1997) was used to assess QoL. The WHOQOL-BREF is suitable for a range of diagnoses and ages (Couston, Cossar, Hayes, O'Carroll, & Smith, 2000). The WHOQOL-BREF is a short form of the 100-item WHOQOL (WHOQOL

Group, 1997), which was developed to assess an individual's perception of their position in life with special attention to their culture and value systems in which they reside, and in relation to their goals, values and concerns (Kamio et al., 2013). It consists of 24 items on four domains of QoL: physical health, psychological, social relationships and environment. These domain scores are scaled in a positive direction (higher scores indicate greater QoL. Two additional questions address the individual's perception of their QoL and health. Each item is assessed on a five-point scale (e.g., 1 = not at all, 2 = a little, 3 = a moderate amount, 4 = very much, 5 = extremely). The WHOQOL-BREF has good validity, with Cronbach's alpha ranged from 0.66 for the social relationship domain to 0.84 for the physical health domain (Jennes-Coussens et al., 2006). Test-retest reliabilities ranged from 0.66 for the social relationship domain and 0.87 for the environment domain.

2.4. Analyses

IBM SPSS Statistical Programme, Version 26 was used in conducting all statistical analyses. A total of nine separate primary analysis models were performed. Four separate multiple linear regression models were initially conducted to identify the associations of gastrointestinal symptoms, sleep problems, social functioning, perceived social support and autism traits with each QoL domain respectively: physical health, psychological, social relationships and environment. For each QoL domain model, GI symptoms (total score of GSI), sleep problems (total score of PSQI), social functioning (total score of SFQ), perceived social support (total score of MSPSS), and autism traits (total score of AQ-10) were included as covariates (See Table 5). Five additional multiple linear regression models were conducted to examine the correlations of the scales of the variables that resulted significant in the four initial regression analyses. PSQI subscales (daytime dysfunction, sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances and sleep medication) and SFQ total scores were included as covariates of the physical health and environment QoL domains while MSPSS subscales (family, friends and significant others) and SFQ total scores were included as covariates of the psychological, social relationship and environment QoL domains (See Table 6). Multicollinearity issues were addressed if any variable had a Pearson correlation coefficient $\geq .7$ or a variance inflation factor (VIF) of ≥ 10 . Hypothesis tests were two-sided, and the significance threshold was set to 0.05. Finally, additional regression analyses with interaction terms were conducted to examine whether the associations found in the main analyses differed by gender.

3. Results

3.1. Demographic information

Sixty-seven percent (67.3 %, $n = 73$) of participants were employed at the time of recruitment, 65.75 % ($n = 48$) of which in a full-time position and 34.25 % ($n = 25$) in a part time position. Thirty-three percent (32.7 %, $n = 35$) of participants reported to be unemployed. Table 1 includes details on the demographic and education characteristics of participants.

3.2. Comorbid psychological disorders

Regarding comorbid psychological disorders, 63.5 % ($n = 68$) reported having one or more psychological disorders. A summary of the number of psychological disorders per participant and an overview of the most common disorders are shown in Table 2. The most common psychological disorder was Mixed Anxiety/Depressive Disorder, affecting 22 % ($n = 28$) of participants, followed by Major Depressive Disorder at 20.5 % ($n = 26$) and Generalized Anxiety disorder at 17.3 % ($n = 22$).

Table 1
Education and employment characteristics of study sample.

	<i>n</i>	%
<u>Level of Education Completed</u>		
Primary/Elementary Completed	6	5.6
Secondary/High School Completed	35	32.7
Undergraduate Degree Completed	44	41.1
Postgraduate Degree Completed	11	10.3
Masters Completed	11	10.3
<u>Education Sector</u>		
Arts/Humanities	6	11.8
Other	18	35.3
Not Stated	27	52.9
<u>Employment</u>		
Employed	73	67.3
Unemployed	35	32.7

Table 2
Psychological disorder characteristics of study sample.

	<i>n</i>	%
<u>Number of Psychological Disorders</u>		
No Psychological disorder	39	36.5
One Psychological disorder	30	28.1
Two Psychological disorders	15	14.0
Three Psychological disorders	14	13.1
Four or More Psychological disorders	9	8.4
<u>Types of psychological disorders</u>		
Major Depressive Disorder	26	20.5
Bipolar Disorder	10	7.8
Attention-deficit/hyperactivity disorder	22	17.3
Post-Traumatic Stress Disorder	15	11.8
Obsessive Compulsive Disorder	14	11.1
Mixed Anxiety Depressive Disorder	28	22.0
Generalized Anxiety Disorder	22	17.3

3.3. Comorbid physical or medical conditions

Twenty-five percent ($n = 27$) of the sample reported having one or more comorbid physical or medical conditions. Fourteen percent ($n = 15$) presented with one physical or medical condition, while 11.2 % ($n = 12$) presented with two or more physical or medical conditions. The most common physical or medical condition was sight impairment (10.2 %, $n = 11$). A summary of the types of physical or medical conditions can be seen in [Table 3](#).

3.4. Autism traits

The mean total AQ-10 score was 7.87 ($SD = 1.79$). This mean score is relatively high as the published cut-off score for the AQ-10 is ≥ 6 . Anything above indicates the presence of autism traits. All participants scored AQ-10 > 6 .

3.5. Gastrointestinal symptoms

The mean total gastrointestinal symptoms was 3.16 symptoms ($SD = 1.85$). Eighty-six percent ($n = 92$) of participants experienced at least one gastrointestinal symptom within the last three months. Seventeen percent (16.8 %, $n = 18$) of participants presented with one symptom only, while 15.0 % ($n = 16$) presented with two symptoms, 18.7 % ($n = 20$) presented with three symptoms, 14 % ($n = 15$) presented with four symptoms, 12.2 % ($n = 13$) presented with five symptoms, and 9.3 % ($n = 10$) presented with six symptoms. The most common gastrointestinal symptom was diarrhea, affecting 61.7 % ($n = 66$) of participants. For an overview of the types of GI symptoms, see [Table 3](#).

3.6. Sleep problems

A score of five or greater was used to indicate a poor sleeper on the PSQI. Eighty-nine percent ($n = 96$) of the sample were found to

Table 3
Physical or medical conditions of study sample.

Condition	<i>n</i>	%
Hearing Impairment	6	5.6
Sight Impairment	11	10.2
Other	13	11.7
<u>Autoimmune</u>		
Diabetes	3	2.8
Hypothyroidism/Hashimoto's	3	2.8
Other	4	3.6
<u>Gastrointestinal Symptoms</u>		
Diarrhea	66	61.7
Abdominal pain	58	54.2
Nausea	51	47.7
Bloating	51	47.7
Constipation	38	35.5
Other	31	29.0

be poor sleepers. A summary of the subscale means, and standard deviations are included in Table 4.

3.7. Social support

The means and standard deviations of the subscales and total are given in Table 4.

3.8. Social functioning

The mean total SFQ score was 12.37 ($SD = 3.70$), range 2–19. Scores greater than 10 are indicative of poorer social functioning. Seventy-one percent (71.03 %, $n = 76$) of participants scored $SFQ > 10$.

3.9. Correlates of quality of life

All covariates in the models were at most moderately correlated. Pearson's correlation coefficient for all covariates were less than .7. The variance inflation factor (VIF) scores were less than 10 (range = 1.08–1.78) and tolerance scores were greater than .1 (range = .561–.926).

3.9.1. Correlates of physical health domain QoL

The regression model including gastrointestinal symptoms, sleep problems, social support, social functioning and autism traits as covariates was significantly related to the physical health domain ($F_{(5,101)} = 6.29, p < .001, R^2 = .24$, adjusted $R^2 = .20$). The overall model accounted for 20 % of the variance in the physical health QoL. The model coefficients revealed that poorer social functioning was significantly correlated with poorer physical health QoL ($\beta = -.35, SE = .42, p = .003$). In addition, greater overall sleep problems were associated with poorer QoL in the physical health domain ($\beta = -.23, SE = .35, p = .03$). However, gastrointestinal symptoms ($\beta = .06, SE = .72, p = .53$), autism traits ($\beta = -.02, SE = .68, p = .87$) and social support ($\beta = .02, SE = .08, p = .85$) were not significantly associated with QoL in the physical health domain.

An additional model was conducted to further examine the relationship between sleep problems and QoL in the physical health domain. The overall model controlling for subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction was statistically significant ($F_{(7, 99)} = 3.83, p = .001, R^2 = .21$, adjusted $R^2 = .16$). Greater sleep problems in daytime dysfunction were not significantly associated with poorer QoL in the physical health domain ($\beta = -.30, SE = 1.77, p = .005$). However, none of the other sleep subscales were significantly associated with physical health QoL.

An additional multiple regression was conducted to further examine the relationship between social functioning and QoL in the physical health domain. The overall model controlling for social functioning was statistically significant ($F_{(1, 105)} = 25.79, p < .001, R^2 = .20$, adjusted $R^2 = .19$). Results showed that poorer social functioning was significantly correlated with poorer physical health QoL ($\beta = -.44, SE = .32, p < .001$).

3.9.2. Correlates of psychological domain QoL

Regression analyses for covariates of QoL in the psychological domain revealed social functioning, and social support as significant correlates. The overall model was significant ($F_{(5,101)} = 15.19, p < .001, R^2 = .43$, adjusted $R^2 = .40$) and accounted for 40 % of the variance in QoL in the psychological domain. Poorer social functioning had a negative impact on QoL in the psychological domain ($\beta = -.47, SE = .44, p < .001$). In addition, greater overall social support was correlated with better QoL in the psychological domain ($\beta = -.19, SE = .1, p = .04$). However, gastrointestinal symptoms ($\beta = -.17, SE = .77, p = .06$), autism traits ($\beta = -.13, SE = .72, p = .1$) and sleep problems ($\beta = .05, SE = .37, p = .59$) were not significantly correlated with QoL in the psychological domain.

Table 4
Subscales, mean scores and standard deviations for PSQI and MSPSS.

	<i>M</i>	<i>SD</i>
<u>Pittsburgh Sleep Quality Index (PSQI)</u>		
Subjective Sleep Quality	1.47	.77
Sleep Latency	1.81	1.07
Sleep Duration	1.24	1.05
Sleep Efficiency	.91	1.09
Sleep Disturbance	1.50	.66
Use of Sleep Medication	.72	1.18
Daytime Dysfunction	1.74	.82
<u>Multidimensional Scale of Perceived Social Support (MSPSS)</u>		
Social Support from family	14.84	7.56
Social Support from friends	14.68	6.98
Social Support from significant other	18.88	7.66
Social Support Total	48.41	16.41

An additional multiple regression was conducted to further examine the relationship between social support and psychological QoL. The overall model controlling for social support from family, significant other and friends was significant ($F_{(3,103)} = 6.04, p = .001, R^2 = .15$, adjusted $R^2 = .13$). Greater perceived availability and adequacy of social support from family ($\beta = .28, SE = .21, p = .004$) were significantly correlated with QoL in the psychological domain. However, social support from friends ($\beta = .13, SE = .24, p = .19$) and significant others ($\beta = .08, SE = .22, p = .41$) were not significantly associated with QoL in the psychological domain.

An additional multiple regression was conducted to further examine the relationship between social functioning and psychological QoL. The overall model controlling for social functioning was statistically significant ($F_{(1, 105)} = 64.37, p < .001, R^2 = .38$, adjusted $R^2 = .37$). Overall, this result suggests that poorer social functioning had a negative impact on QoL in the psychological domain ($\beta = -.62, SE = .34, p < .001$).

3.9.3. Correlates of social relationships domain QoL

Regression analyses for covariates of QoL in the social relationship's domain revealed social functioning, and social support as significant correlates. The overall model was significant ($F_{(5,101)} = 36.16, p < .001, R^2 = .64$, adjusted $R^2 = .62$) and accounted for 62 % of the variance in QoL in the social relationship's domain. Poorer social functioning was negatively correlated with QoL in the social relationship's domain ($\beta = -.47, SE = .51, p < .001$). In addition, greater overall social support was associated with an increase in social relationships QoL ($\beta = .52, SE = .10, p < .001$). However, gastrointestinal symptoms ($\beta = -.07, SE = .07, p = .33$), autism traits ($\beta = -.04, SE = .81, p = .53$) and sleep problems ($\beta = .12, SE = .41, p = .1$) were not significantly associated with QoL in the social relationships domain.

An additional multiple regression was conducted to further examine the relationship between social support and social relationships QoL. The overall model controlling for social support from family, significant other and friends was significant ($F_{(3,103)} = 35.72, p < .001, R^2 = .51$, adjusted $R^2 = .50$). Results showed that greater perceived availability and adequacy of social support from each source; friends ($\beta = .40, SE = .26, p < .001$), family ($\beta = .32, SE = .23, p < .001$), or significant other ($\beta = .24, SE = .24, p = .002$) were significantly correlated with QoL in the social relationships domain.

An additional multiple regression was conducted to further investigate the relationship between social functioning and social relationships QoL. The overall model controlling for social functioning was statistically significant ($F_{(1, 105)} = 66.77, p < .001, R^2 = .39$, adjusted $R^2 = .38$). This result reveals that poorer social functioning was negatively correlated with QoL in the social relationship's domain ($\beta = -.62, SE = .49, p < .001$).

Table 5
Summary of Multiple Regression Model Results.

Variable	<i>B</i>	<i>p</i>	<i>R</i> ²	<i>Adj. R</i> ² <i>change</i>	<i>F change</i>
Physical Health Domain QoL					
			.24	.20	6.29
SFQ total	−.35	<.01**			
PSQI total	−.23	.03*			
MSPSS	.02	.85			
GI Symptom Inventory total	.06	.53			
AQ-10	−.02	.87			
Psychological Domain QoL					
			.43	.40	15.19
SFQ total	−.47	<.01**			
PSQI total	.05	.59			
MSPSS	.19	.04*			
GI Symptom Inventory total	−.17	.06			
AQ-10	−.13	.10			
Social Relationship Domain QoL					
			.64	.62	36.16
SFQ total	−.47	<.01**			
PSQI total	.12	.10			
MSPSS	.52	<.01**			
GI Symptom Inventory total	.07	.33			
AQ-10	−.04	.53			
Environment Domain QoL					
			.40	.37	13.55
SFQ total	−.39	<.01**			
PSQI total	−.20	.02*			
MSPSS	.20	.03*			
GI Symptom Inventory total	−.02	.84			
AQ-10	−.02	.79			

* $p < .05$.

** $p < .01$.

3.9.4. Correlates of environment domain QoL

Regression analyses for covariates of QoL in the environment domain revealed social functioning, social support and sleep problems as significant correlates. The overall model was significant ($F_{(5,101)} = 13.55, p < .001, R^2 = .40$, adjusted $R^2 = .37$) and accounted for 37 % of the variance of QoL in the environment domain. The model coefficients revealed that poorer social functioning ($\beta = -.39, SE = .58, p < .001$) and greater overall sleep problems ($\beta = -.20, SE = .47, p = .02$) were significantly correlated with poorer QoL in the environment domain. In addition, greater overall social support was associated with an increase in the environment QoL ($\beta = .20, SE = .12, p = .03$). Gastrointestinal symptoms ($\beta = -.02, SE = .99, p = .84$) and autism traits ($\beta = -.02, SE = .93, p = .79$) were not significantly correlated with QoL in the environment domain.

An additional multiple regression was conducted to further examine the relationship between social support and environment QoL. The overall model controlling for social support from family, significant other and friends was significant ($F_{(3,103)} = 10.36, p < .001, R^2 = .23$, adjusted $R^2 = .21$). Greater perceived availability and adequacy of social support from family ($\beta = .43, SE = .26, p < .001$) were significantly correlated with QoL in the environment domain. However, social support from friends ($\beta = .08, SE = .29, p = .42$) and significant others ($\beta = .05, SE = .26, p = .59$) were not significantly associated with QoL in the environment domain.

An additional multiple regression was conducted to further investigate the relationship between sleep problems and environment

Table 6

Multiple Regression Results, including subscales of each significant variable.

Variable	B	p	R ²	Adj. R ² change	F change
Physical Health Domain QoL					
PSQI subscales			.21	.16	3.83
Daytime dysfunction	-.30	<.01**			
Sleep quality	-.10	.43			
Sleep latency	-.07	.52			
Sleep duration	-.07	.54			
Sleep efficiency	-.20	.08			
Sleep disturbances	.06	.61			
Sleep Medication	.05	.61			
SFQ total	-.44	<.01**	.20	.19	25.79
Gender*SF total	-.34	<.01**	.11	.10	13.44
Gender*PSQI total	-.30	<.01**	.09	.08	10.35
Psychological Domain QoL					
MSPSS subscales			.15	.13	6.04
Family	.28	<.01**			
Friends	.13	.19			
Significant others	.08	.41			
SFQ total	-.62	<.01**	.38	.37	64.37
Gender*SF total	-.44	<.01**	.19	.19	25.22
Gender*MSPSS Total	.02	.83	.00	-.01	.05
Social Relationship Domain QoL					
MSPSS subscales			.51	.50	35.72
Family	.32	<.01**			
Friends	.40	<.01**			
Significant others	.24	<.01**			
SFQ total	-.62	<.01**	.39	.38	66.77
Gender*SF total	-.09	.34	.01	-.001	.93
Gender*MSPSS Total	.41	<.01**	.17	.16	21.62
Environment Domain QoL					
MSPSS subscales			.23	.21	10.36
Family	.43	<.01**			
Friends	.08	.42			
Significant others	.05	.59			
PSQI subscales			.28	.22	5.4
Daytime dysfunction	-.25	.02*			
Sleep quality	-.08	.54			
Sleep latency	-.16	.12			
Sleep duration	-.22	.04*			
Sleep efficiency	.03	.81			
Sleep disturbances	-.14	.19			
Sleep Medication	.09	.33			
SFQ total	-.58	<.01**	.34	.33	53.13
Gender*SF total	-.32	<.01**	.10	.09	12.13
Gender*PSQI Total	-.29	<.01**	.08	.07	9.64
Gender*MSPSS Total	.09	.37	.01	-.002	.80

* $p < .05$.

** $p < .01$.

QoL. The overall model controlling for subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction was statistically significant ($F_{(7, 99)} = 5.4, p < .001, R^2 = .28$, adjusted $R^2 = .22$). Results suggested that greater sleep problems in daytime dysfunction ($\beta = -.25, SE = 2.63, p = .02$) and sleep duration ($\beta = -.22, SE = 2.14, p = .04$) were correlated with poorer QoL in the environment domain. However, sleep quality ($\beta = -.08, SE = 3.33, p = .54$), sleep latency ($\beta = -.16, SE = 2.04, p = .12$), sleep efficiency ($\beta = -.03, SE = 2.02, p = .81$), sleep disturbance ($\beta = -.14, SE = 3.32, p = .19$) and use of medication ($\beta = -.09, SE = 1.64, p = .33$) were not significantly associated with QoL in the environment domain.

An additional multiple regression was conducted to further examine the relationship between social functioning and environment QoL. The overall model controlling for social functioning was significant ($F_{(1, 105)} = 53.13, p < .001, R^2 = .34$, adjusted $R^2 = .33$). Poorer social functioning was negatively correlated with QoL in the environment domain ($\beta = -.58, SE = .45, p < .001$). [Tables 5 and 6](#) gives a summary of the regression analyses.

3.10. Gender differences

A series of additional regression analyses with interaction terms were conducted to examine whether gender had an effect on the significant correlations found in the main analyses between SF Total, PSQI Total, MSPSS Total and QoL domains (See [Table 6](#)).

3.10.1. Gender differences on physical health domain QoL

The regression analysis with the interaction term Gender* SFQ Total showed that the association between SF and Physical Health Domain QoL differed significantly by gender ($F_{(1, 105)} = 13.44, p < .01, R^2 = .11$, adjusted $R^2 = .10$). The effect of SFQ total on Physical Health Domain QoL was more negative for female participants compared to male participants ($\beta = -.34, SE = .19, p < .01$). As the SFQ Total score increased (poorer SF), the level of Physical Health Domain QoL decreased more steeply for females than for males.

The regression analysis with the interaction term Gender*PSQI Total showed that the association between PSQI Total and Physical Health Domain QoL differed significantly by gender ($F_{(1, 105)} = 13.44, p < .01, R^2 = .09$, adjusted $R^2 = .08$). The effect of PSQI Total on Physical Health Domain QoL was more negative for male participants compared to female participants ($\beta = -.30, SE = .22, p < .01$). As the PSQI Total score increased (greater sleep problems), the level of Physical Health Domain QoL decreased more steeply for males than for females.

3.10.2. Gender differences on psychological domain QoL

The regression analysis with the interaction term Gender* SFQ Total showed that the association between SFQ total and Psychological Domain QoL differed significantly by gender ($F_{(1, 105)} = 25.22, p < .01, R^2 = .19$, adjusted $R^2 = .19$). The effect of SFQ total on Psychological Health Domain QoL was more negative for female participants compared to male participants ($\beta = -.44, SE = .22, p < .01$). As the SFQ Total score increased (poorer SF), the level of Psychological Domain QoL decreased more steeply for females than for males.

Finally, the regression analysis with the interaction term Gender*MSPSS Total showed that the association between perceived social support and Psychological Domain QoL did not differ significantly by gender ($F_{(1, 105)} = .05, p = .83, R^2 = .00$, adjusted $R^2 = -.01$).

3.10.3. Gender differences on social relationship domain QoL

The regression analysis with the interaction term Gender* SFQ Total showed that the association between SFQ total and Social Relationship Domain QoL did not differ significantly by gender ($F_{(1, 105)} = .93, p = .34, R^2 = .01$, adjusted $R^2 = -.001$).

Finally, the regression analysis with the interaction term Gender*MSPSS Total showed that the association between perceived social support and Social Relationship Domain QoL differed significantly by gender ($F_{(1, 105)} = 21.62, p < .01, R^2 = .17$, adjusted $R^2 = .16$). The effect of MSPSS Total on Social Relationship Domain QoL was more positive for male participants compared to female participants ($\beta = .41, SE = .08, p < .01$). As perceived availability and adequacy of social support increased, the level of Social Relationship QoL increased more steeply for males than for females.

3.10.4. Gender differences on environment domain QoL

The regression analysis with the interaction term Gender* SFQ Total showed that the association between SFQ total and Environment Domain QoL differed significantly by gender ($F_{(1, 105)} = 12.13, p < .01, R^2 = .10$, adjusted $R^2 = .09$). The effect of SFQ total on Environment Domain QoL was more negative for female participants compared to male participants ($\beta = -.32, SE = .29, p < .01$). As the SFQ Total score increased (poorer SF), the level of Environment Domain QoL decreased more steeply for females than for males.

In addition, the regression analysis with the interaction term Gender*PSQI Total showed that the association between PSQI Total and Environment Domain QoL differed significantly by gender ($F_{(1, 105)} = 9.64, p < .01, R^2 = .08$, adjusted $R^2 = .07$). The effect of PSQI Total on Environment Domain QoL was more negative for male participants compared to female participants ($\beta = -.29, SE = .34, p < .01$). As the PSQI Total score increased (greater sleep problems), the level of Environment Domain QoL decreased more steeply for males than for females.

Finally, the regression analysis with the interaction term Gender*MSPSS Total showed that the association between MSPSS total and Environment Domain QoL did not differ significantly by gender ($F_{(1, 105)} = .80, p = .37, R^2 = .01$, adjusted $R^2 = -.002$).

4. Discussion

This study investigated the predictive value of gastrointestinal symptoms, sleep problems, social support, autism traits and social functioning across each domain of QoL in adults with ASD. This study provides the first evidence that sleep problems are significantly correlated with QoL in adults with ASD. The majority (89 %) of adults with ASD presented with sleep problems. Daytime dysfunction was found to be correlated with physical QoL, and sleep duration and daytime dysfunction were significantly correlated with environment QoL. These findings indicated that adults who have greater problems with daytime dysfunction and sleep duration are more likely to experience poorer QoL.

Previous research conducted with children with ASD showed a negative relationship between overall sleep problems and total, physical, and psychosocial HRQoL in children with ASD (Delahaye et al., 2014). This new finding of the current study highlights that sleep disturbances persist into adulthood, suggesting that they are a lifelong condition in individuals with ASD. This finding also highlights the importance of addressing sleep disturbances in childhood, since the effects can persist and negatively impact QoL in adulthood. Delahaye et al. (2014) found that sleep duration and sleep anxiety were negatively related to overall and psychosocial HRQoL in children with ASD. The current study did not examine sleep anxiety but the relationship between sleep anxiety and QoL in adults with ASD would be an avenue worth exploring in future research.

Results also showed that poorer social functioning was negatively correlated with QoL across the four domains. Adults with poorer social functioning were more likely to experience poorer QoL in the physical health, psychological, social relationships, and environment domains. This finding suggests that an individual's interactions with their environment plays a crucial role in the perception of their position in life. Furthermore, although this was the first study to examine the predictive value of social functioning across QoL domains, future research should examine the predictive value of each social functioning domain to better understand where more support is needed.

This study showed that social support was significantly correlated with QoL in the psychological, social relationships, and environment domains. Greater perceived availability and adequacy of social support from family were associated with increase of QoL in the psychological and environment domains. In addition, greater social support from each source; friends, family and significant others, were significantly associated with QoL in the social relationship's domain. This study shed light on the importance of social support from friends, family and significant others for adults with ASD. This finding is similar to previous research which found that perceived social support was correlated QoL in adults with ASD (Renty & Roeyers, 2006). In addition, Khanna et al. (2014) found that greater perceived adequacy of social support from friends and family significantly predicts higher mental HRQoL. Similar to this, Kamio et al. (2013) found that greater social support from mothers was associated with higher QoL.

Although previous studies investigating the relationship between autism severity and QoL found a negative association between autism severity and mental HRQoL (Khanna et al., 2014), in the present study, autism traits were not significantly associated with any QoL domain. This finding is similar to other research, which found no relationship between autism severity and overall QoL (Kamp-Becker et al., 2010; Renty & Roeyers, 2006). A large proportion of the sample presented with severe autism symptoms. It could be hypothesised that although autism severity did not primarily influence QoL in this study, other underlying factors such as poor social functioning and sleep problems that commonly are described as symptoms of ASD or that commonly co-occur with ASD were linked to decreased QoL.

Regarding GI symptoms, the majority (86 %) of adults with ASD were affected by at least one GI symptom within the last three months. However, although this was the first study to examine the relationship between GI symptoms and QoL, the present study did not provide evidence of any significant predictive value of GI symptoms in any of the QoL domains.

With regard to comorbid physical or medical conditions, 25.7 % of adults with ASD reported having one or more comorbid physical or medical conditions. This prevalence estimate lies between numbers reported in previous research of 10.4 % (Kamio et al., 2013) and 33 % (Khanna et al., 2014) of participants with a comorbid physical condition. These findings suggest a significant physical burden in this population. Khanna et al. (2014) reported that adults who had a diagnosis of a physical illness had lower physical QoL than those who did not. However, the relationship between physical illness and QoL needs to be investigated in future research.

With regard to comorbid psychological disorders, 63.5 % of adults with ASD reported having at least one comorbid psychological disorder. This is a higher prevalence estimate than what was found in previous research, where over a third of participants (43 %; Hofvander et al., 2009; 37.7 %; Kamio et al., 2013; 36.8 %; Khanna et al., 2014) reported having a mental or psychiatric condition. The present study found that 20.5 % of adults with ASD reported having Major Depressive Disorder. Lugnegård et al. (2011) reported a much higher finding with 70 % of participants with ASD experiencing at least one major depressive episode and 50 % reporting recurrent episodes. In addition, results of this current study suggested that 17.3 % of adults with ASD reported having Generalized Anxiety Disorder, this is similar to previous research (18 %; Hofvander et al., 2009; 22 %; Lugnegård et al., 2011).

In this study, a large percentage of participants were female (70.1 %), which does not reflect current understandings of the ratio of males to females with ASD. It is possible that the high number of female participants was due to the recruitment method that was used. Recruitment took place on social media. It is possible that females with ASD feel more comfortable taking part in research through social media and that social media is useful for females with ASD in particular. However, this is an avenue for future research in order to determine what the most useful ways of recruiting female participants with ASD are.

Research has raised the idea that the discrepancy in ASD diagnosis may be the result of differences in symptom presentation including differences in internalizing behaviors, repetitive behaviors, self-injurious behaviors and other challenging behaviors. There is also some evidence that indicates that females with ASD have more social impairments than males (Bargiela, Steward, & Mandy, 2016; Frazier, Georgiades, Bishop, & Hardan, 2014). Research has also suggested that many tools developed to assess for ASD were validated using predominately male samples with may affect an assessment's sensitivity to ASD symptoms among females (Koenig &

Tsatsanis, 2005; Rutter, Caspi, & Moffitt, 2003). Therefore, it is important to consider the gender differences related in ASD and what it means for QoL in this population. Although not statistically significant, mean differences for gender and QoL show that females have a lower QoL compared to males across physical and environment domains, and have significantly lower physical QoL compared to males.

Similar to research by Mason et al. (2018), it could be hypothesised that females with ASD have a poorer QoL compared to males with ASD. Results from this study also indicated that females have a higher QoL compared to males in the social domain of the WHOQOL-BREF. This finding is supported by research indicating that females with ASD are more socially motivated and able to maintain more friendships than males (Bargiela et al., 2016). Future research is needed to further explore the gender differences of QoL in ASD as it is difficult to generalise the findings. It raises the question whether findings can be generalised across both male and female populations when ASD presents very differently in each. Future work is needed to further explore the gender differences in ASD.

While the results of this study yielded some new findings, the present study has also some limitations. First, self-report was utilized to gather information and, although this is a validated methodology, it relies on subjective accounts. As the study was a cross-sectional study, causality cannot be inferred. Therefore, while it can be claimed that the variables predict QoL in a specific domain, changes in QoL may originate in other, unknown variables predicting QoL. This study's sample has a high percentage of female participants and this does not reflect current understandings of the ratio of males to females with ASD. Future research should account for this and obtain an equal sample of female and male participants. Similarly, a high number of participants in this study have graduated college and are employed. This may be viewed as a select group and the results of this study may not be generalizable to other adults with ASD.

The present study provides evidence of unexplored significant correlates of QoL in adults with ASD. The results highlight the relevance of sleep problems on QoL, which was significantly correlated with two QoL domains. In addition, social support was significantly associated with three QoL domains. Finally, poorer social functioning was negatively correlated with QoL in each domain, suggesting that poor social functioning may be a key factor to be addressed in order to increase the overall QoL in this population. Considering that the number of studies investigating correlates of QoL in adults with ASD in the literature is limited, this study expanded upon existing literature and provided informative value that can guide therapeutic interventions to help adults with ASD live satisfactory lives.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of National University of Ireland Galway and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

CRediT authorship contribution statement

Geraldine Leader: Conceptualization, Methodology, Supervision, Writing - review & editing, Visualization. **Amy Barrett:** Investigation, Formal analysis, Writing - original draft. **Chiara Ferrari:** Formal analysis, Writing - review & editing. **Mia Casburn:** Formal analysis, Writing - review & editing. **Leanne Maher:** Formal analysis, Writing - review & editing. **Katie Naughton:** Formal analysis, Writing - review & editing. **Sophia Arndt:** Formal analysis, Writing - review & editing. **Arlene Mannion:** Conceptualization, Methodology, Supervision, Writing - original draft, Writing - review & editing, Visualization.

Declaration of Competing Interest

The authors report no declarations of interest.

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