Health Status of Adults with Autism Spectrum Disorder

Jennifer Forde¹ · Paola Molina Bonilla¹ · Arlene Mannion¹ · Rory Coyne¹ · Ross Haverty¹ · Geraldine Leader¹

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Abstract

Individuals diagnosed with autism spectrum disorder (ASD) have a higher probability of developing co-occurring mental or physical health conditions. However, little is known about how these health conditions develop and impact the lives of the adult ASD population. This paper reviewed existing studies concerning factors affecting the health status of adults with ASD and described their outcomes and prevalence. A systematic search of electronic databases yielded 21 studies eligible to be included. The most common physical problems affecting health were epilepsy and immune, gastrointestinal, and sleep disorders. Mental health disorders, most prominently mood and anxiety disorders and OCD, were also strong factors for determining health in adults. Future research should focus on measuring the overall health status of the adult ASD population.

Keywords Autism spectrum disorder · Comorbidity · Adults · Health · Gastrointestinal · Sleep

The most recent estimate suggests that 1 in 54 children in the USA alone is diagnosed with autism spectrum disorder (ASD; Maenner et al., 2020). Although much knowledge has been acquired regarding the neuroanatomy of those with ASD, and the neurobiological functions related to it, little advances have been made which directly relate to the overall health status of an individual with ASD. Some of the first and most commonly diagnosed medical conditions affecting health status for the ASD population are related to the immune system (allergies, asthma, and autoimmune disorders like diabetes and psoriasis) and are usually diagnosed during the early years of infancy (Zerbo et al., 2015).

Comorbidity is defined within the literature as the co-occurrence of two or more disorders within the same individual (Matson & Nebel-Schwalm, 2007). Comorbid conditions that co-occur in ASD include attention-deficit/hyperactivity disorder (ADHD), epilepsy, sleep problems, gastrointestinal symptoms, behaviour problems, and toileting and feeding issues (Devlin et al., 2008; Leader et al., 2018; Leader & Mannion, 2016a, b; Leader et al., 2020; Mannion & Leader, 2014a, b). Research has only begun to study these comorbid

conditions in developmental disabilities other than ASD (Newman et al., 2015).

Mannion and Leader (2013b) addressed within a literature review the prevalence of comorbidity and psychopathology rates in children, adolescents, and adults with ASD by recording the outcomes of previous studies using structured clinical interviews and tools specifically designed for ASD, such as the Psychopathology in Autism Checklist (PAC; Helters et al., 2009), Autism Spectrum Disorders-Comorbidity for Adults (ASD-CA; Matson and Boisjoli (2008), and Diagnostic Assessment for the Severely Handicapped-revised (DASH; Matson, 1995). Mannion and Leader (2013b) emphasised the need to understand the comorbid disorders commonly affecting the ASD population and design the most appropriate intervention plan for that individual.

A further point that requires thorough investigation is the impact of comorbidity in ASD on the outcomes of the individual into adulthood. While few studies have assessed the impact of comorbidity on daily life in child ASD samples, fewer still have assessed this impact on adult samples. For example, comorbidity in child ASD has been shown to predict greater need for behavioural services (Kim et al., 2012). Additionally, children with ASD and ADHD demonstrate deficits in executive functioning as adults (Fischer et al., 2005). Kohane et al. (2012) assessed comorbidity burden in individuals with ASD and found that three of the comorbidities (bowel disorders, sleep disorders, and epilepsy) did not change

✉ Geraldine Leader
geraldine.leader@nuigalway.ie

¹ Irish Centre for Autism and Neurodevelopmental Research (ICAN), School of Psychology, National University of Ireland, Galway Ireland

significantly with age. However, diabetes mellitus type 1, schizophrenia, and irritable bowel disorder did increase significantly with age (Kohane et al., 2012).

Accurately diagnosing multiple medical conditions in an individual with ASD is not always an easy, straightforward task, as many that receive their ASD spectrum diagnosis are children and have limited or no verbal skills to communicate physical discomfort or pain appropriately, cooperate poorly during a medical exam, or have sensory deficits that will affect how they process pain in their bodies (Bauman, 2010). In such cases, identifying comorbidities will frequently go unnoticed by primary care providers, and important medical conditions will not be diagnosed or treated even as the child transitions to adulthood.

ASD is a lifelong neurodevelopmental disorder, and there is still not enough information about the mental and physical health of adults with the disorder. This is one of the biggest problems being faced at present by practitioners and service users alike. There is a concerning lack of comprehensive understanding of the neurobiological systems affected in an individual with an ASD diagnosis and how these evolve and change throughout their lifespan. New research is now addressing these gaps by illustrating the prevalence and rates of comorbidity in individuals with ASD and by investigating other factors that are directly related to the overall physical and psychological health of these individuals (Mannion & Leader, 2013a, 2016; Mason et al., 2018). This knowledge is needed in order to provide evidence-based treatment in adult-specialised services and design comprehensive healthcare packages that include not only the service user, but take into account their caregivers as well, as it has been shown that these individuals will perform best if well-integrated within a strong family and community support system (Murphy et al., 2016).

Current Study

Research has demonstrated the crucial importance to correctly diagnose and acquire more knowledge regarding related medical conditions and mental health factors that manifest in the ASD population, since many of the conditions are treatable and could result in an improved quality of life for the individual as well as the family. The purpose of this review is to survey the literature for psychopathologies and medical conditions which have been identified in adults with ASD. This review sought to ascertain prominent mental or physical health-related disorders present in adults with ASD and determine which of these are the most prevalent in this population and how they contribute to the overall health status of the individual. The final aim of the current study was to assess the extent to which comorbidity in ASD leads to poorer outcomes in adulthood.

Method

Search Procedure

An extensive literature search was conducted to identify published studies describing the health status of adults with ASD in several online databases. The online search utilised the databases SCOPUS, PubMed, ScienceDirect, and the National Center for Biotechnology Information (NCBI) and combined the input of the following search terms: “autism spectrum disorder”, “adult”, and “health”. A secondary search was then conducted adding the search terms “health status”, “medical”, “comorbid*”, or “immune”. The abstracts of the resulting studies were carefully reviewed to determine studies eligible for inclusion.

Inclusion Criteria

The abstracts from the articles obtained from the search were reviewed to identify those meeting the following criteria for inclusion: (a) age of participants in the study must be equal to or greater than 18 years, (b) population must include adults with a confirmed diagnosis of ASD, (c) they must describe quantitative results from empirical studies of health-related studies for individuals with ASD, (d) publication date must be from 2000 to 2017, and (e) they must be published in English peer-reviewed journals.

Results

The initial search using the first set of search terms yielded a total of 14,393 results from all databases. After the secondary search was conducted, adding the second set of search terms, the results were narrowed down to 91 total studies. After the abstracts were carefully reviewed using the above inclusion criteria, a total of 21 articles were deemed eligible for inclusion in this review. These remaining articles were then categorised according to the type of health-related factor examined (e.g. sleep problems, chronic disease, comorbid psychopathology). The PRISMA flow diagram is included in Figure 1. Inter-observer reliability was assessed by two independent reviewers (RC and RH) based on a random sample of 25% of the 91 identified studies. There was a perfect agreement among reviewers (Cohen’s $k = 1$).

Sample Characteristics

Sample sizes ranged from 17 to 6122 participants. All studies included adults from 18 years to 71 years old. The follow-up period was no more than 4 years where possible within the studies chosen. A diagnosis of ASD was evident in all participants from each study chosen, but in some studies,

Fig. 1 PRISMA flow diagram

participants also had a comorbid intellectual disability. This systematic review involved studies including male and female adults. Table 1 provides a summary of the articles.

Chronic Disease

Tyler et al. (2011) used electronic health record (EHR) analysis to examine prevalence rates of chronic disease, including obesity, in young adults, both male and female, with ASD. The results showed that the rates of chronic disease was 34.9% for obesity, 31.5% for hyperlipidaemia, and 19.4% for hypertension. The study compared this group with a control cohort from the same health system and found that receiving a diagnosis of hyperlipidaemia was more likely in the ASD group. The author pointed out that those with ASD who are without intervention appear to be at significant risk for developing diabetes, coronary heart disease, and cancer by midlife.

Chen et al. (2016) examined the association between ASD and type 2 diabetes. They used a Health Insurance Research Database to enrol a large sample of individuals with ASD, followed them up over a 2-year period, and compared their risk of developing type 2 diabetes to age-matched controls. It was found that young adults had a higher risk of developing type 2 diabetes than those without ASD. It was noted that short-term and long-term use of atypical antipsychotics was associated with a higher likelihood of subsequent type 2 diabetes.

Jones et al. (2016) examined the medical history of adults with ASD, employing a 25-year follow-up from their initial assessment in the mid-1980s to between 2006 and 2011. Questionnaire data on medical symptoms and disorders were collected, as well as medication use and hospitalisation over the study period. The most common medical conditions were seizures, obesity, insomnia, and constipation. Interestingly they found that the median number of medical conditions per person was 11.

Table 1 Summary of studies on health status of adults with autism spectrum disorder

Authors	Diagnosis	Age of participants	Number of participants	Type of health	Title	Outcome
Baker and Richdale (2017)	ASD	18 and over	36	Physical and mental health	Examining the behavioural sleep-wake rhythm in adults with autism spectrum disorder and no comorbid intellectual disability	Participants completed a 14-day sleep-wake diary assessment. Results indicated that a higher proportion of adults with ASD met criteria for a circadian rhythm sleep-wake disorder compared to control adults. Delayed sleep-wake phase disorder was particularly common in adults with ASD. Results suggested that adults with ASD have sleep patterns associated with circadian rhythm disturbance; however, employment status and comorbid anxiety and/or depression appear to influence their sleep patterns
Baker et al. (2017)	ASD	18 and over	60	Physical health	Assessing the dim light melatonin onset in adults with autism spectrum disorder and no comorbid intellectual disability	Sixteen adults with ASD (ASD-Only), 12 adults with ASD medicated for comorbid diagnoses of anxiety and/or depression (ASD-Med), and 32 controls participated in the study. Overall mean melatonin levels were lower in the ASD-Med group compared to that in the two other groups. Lastly, greater increases in melatonin in the hour prior to sleep were associated with greater sleep efficiency in the ASD groups
Buck et al. (2014)	ASD	18 and over	129	Mental health	Psychiatric comorbidity and medication use in adults with autism spectrum disorder	The comorbid psychiatric disorders and psychotropic medication use among adults with autism spectrum disorder (ASD) ascertained as children during a 1980's statewide Utah autism prevalence study were investigated. It was found that 56.6% met criteria for a current psychiatric disorder and 69.0% met lifetime criteria for a psychiatric disorder. Caregivers reported a psychiatric diagnosis in 34.1% of participants
Chen et al. (2016)	ASD	18–22	6122	Physical health	Risk of developing type 2 diabetes in adolescents and young adults with autism spectrum disorder: a nationwide longitudinal study	Adolescents and young adults with ASD had a higher risk of developing type 2 diabetes than those without ASD, after adjustment for demographic data, atypical antipsychotics use, and medical comorbidities. Sensitivity analyses after excluding first year and first 3-year observation periods were consistent. Short-term and long-term use of atypical antipsychotics were associated with a higher likelihood of subsequent type 2 diabetes
Croen et al. (2015)	ASD	18 and over	1507 with ASD diagnoses 15,070 control group	Physical and mental health	Health status of adults on the ASD spectrum	The objective of this study was to describe the frequency of psychiatric and medical conditions among a large, diverse, insured population of adults with ASD in the USA. Adults with ASD had significantly increased rates of all major psychiatric disorders and medical conditions
Fortuna et al. (2016)	ASD	18–71	220	Physical and mental health	Health conditions and functional status in adults with autism: a cross-sectional evaluation	Adults with ASD have a high prevalence of seizure disorders and depression, but low rates of sexually transmitted infections, tobacco use, and alcohol misuse. Within our cohort, the majority of older adults with ASD required some assistance with activities of daily living
	ASD	18–64	92			

Table 1 (continued)

Authors	Diagnosis	Age of participants	Number of participants	Type of health	Title	Outcome
Gerber et al. (2017)				Physical and mental health	Brief report: factors influencing healthcare satisfaction in adults with autism spectrum disorder	Participants or their caregiver completed a survey about their experiences with primary care and specialty physicians. Participants under age 26 reported significantly higher levels of satisfaction than participants above age 26. They were more likely to live at home or have private health insurance indicating that a good family and community support will impact their healthcare satisfaction
Hamm and Yun (2019)	ASD	18–35	320	Physical and mental health	Influence of physical activity on the health-related quality of life of young adults with and without autism spectrum disorder	The presence of ASD significantly predicted overall health-related quality of life, the physical health domain, psychological domain, and the environment domain. Additionally, physical activity significantly predicted each domain and overall health-related quality of life regardless of the presence of autism spectrum disorder
Helverschou and Martinsen (2011)	ASD, intellectual disability	18 and over	62	Mental health	Anxiety in people diagnosed with autism and intellectual disability: recognition and phenomenology	The results indicated that anxiety can be recognised by symptoms similar to those in non-autistic individuals, but signs of physiological arousal seem difficult to recognise in this population. The results imply inclusion of general adjustment problems in order to identify individuals with anxiety problems by using a checklist. For diagnostic purposes, the use of an individual anxiety assessment seems indicated
Jones et al. (2016)	ASD	25-year study from children—mean age at follow-up 36	92	Physical health	A description of medical conditions in adults with autism spectrum disorder: a follow-up of the 1980s Utah/UCLA autism epidemiologic study	The most common medical conditions were seizures, obesity, insomnia, and constipation. The median number of medical conditions per person was 11. Increased medical comorbidity was associated with female gender and obesity but not intellectual disability. Adults in this cohort of autism spectrum disorder first ascertained in the 1980s experience a high number of chronic medical conditions, regardless of intellectual ability
Khanna et al. (2014)	ASD	18 and over	291	Physical and mental health	Health-related quality of life and its determinants among adults with autism	Results revealed adults with ASD to have significantly lower physical and mental health-related quality of life (HRQOL) than their counterparts in the US population. Factors including social support and coping along with other sociodemographic and medical characteristics were identified as significant predictors of physical and mental HRQOL
Kohane et al. (2012)	ASD	Two groups 0–17 and 18–35 years	14,831 participants	Physical and mental health	The comorbidity burden of children and young adults with autism spectrum disorders	Used electronic health records to assess the comorbidity burden of ASD in under 18 year olds to 18–34 year olds. Three of the studied comorbidities increased significantly when comparing ages 0–17 vs. 18–34 with $P < 0.001$: schizophrenia (1.43% vs. 8.76%), diabetes mellitus type 1 (0.67% vs. 2.08%), and irritable bowel disorder (IBD; 0.68% vs. 1.99%); whereas sleeping disorders, bowel disorders (without IBD), and epilepsy did not change significantly
	ASD	19–79	247 ASD			

Table 1 (continued)

Authors	Diagnosis	Age of participants	Number of participants	Type of health	Title	Outcome
Lever and Geurts (2016)			208 control	Mental health	Psychiatric co-occurring symptoms and disorders in young, middle-aged, and older adults with autism spectrum disorder	Comparable to other psychiatric patients, adults with ASD showed high levels of symptoms and psychological distress over the adult lifespan. Over 65 % of the adults with ASD meeting criteria for any lifetime mood or anxiety disorder also met criteria for the other co-occurring disorder
Limoges et al. (2013)	ASD	18–25	17	Physical health	Relationship between poor sleep and daytime cognitive performance in young adults with autism	Individuals with autism showed clear signs of poor sleep. Their performance differed from the controls in response speed but not in accuracy. Some signs reflecting the presence of poor sleep in adults with high-functioning autism correlate with various aspects of motor output on nonverbal performance tasks
Spain et al. (2016)	ASD	18 and over	50	Mental health	Social anxiety in adult males with autism spectrum disorders	Twenty-six participants (52%) endorsed levels of social anxiety that exceeded the suggested threshold for the disorder. Categorical and dimensional data analyses indicated that there were no relationships between SA symptoms, present state or childhood ASD symptom severity, or measures of socioemotional processing in this sample
Totsika et al. (2010)	ASD, intellectual disability	50 years or older	46	Physical and mental health	Behaviour problems, psychiatric symptoms, and quality of life for older adults with intellectual disability with and without autism	Intellectual disability (ID) and the triad of impairments characteristic of ASD were compared to peers with ID only, and younger adults with ASD and ID. Older adults with ASD did not differ from those with ID in terms of behaviour problems, psychiatric disorder, and quality of life. Any differences in the skills of adults with ASD were associated with decreased adaptive skills and not the presence of ASD per se
Tyler et al. (2011)	ASD	18 and over	108	Physical and mental health	Chronic disease risks in young adults with autism spectrum disorder: forewarned is forearmed	Used electronic health record (EHR) analysis to examine prevalent and future health risks of persons with disabilities. Rates of chronic disease included 34.9% for obesity, 31.5% for hyperlipidaemia, and 19.4% for hypertension. Compared with a control, adults with ASD were more likely to be diagnosed with hyperlipidaemia. Without intervention, they appear to be at risk for developing diabetes, coronary heart disease, and cancer by midlife
Vogan et al. (2017)	ASD	18–61 years	40	Physical and mental health	Tracking health care service use and the experiences of adults with autism spectrum disorder	Examined a diverse range of medical and mental health services and supports, as well as adults' personal experiences accessing and using these services, and barriers to service use. Results indicated that beyond a family doctor, the most commonly used services were dentistry and psychiatry. Individuals who had medical problems experienced significantly more barriers to service use than those who did not
Wakeford et al. (2015)	ASD, epilepsy	18 and over	163	Physical health	Autistic characteristics in adults with epilepsy and perceived seizure activity	These results suggested that adults with epilepsy have higher autistic characteristics measured by the social responsiveness scale, while sameness behaviours remain unimpaired.

Table 1 (continued)

Authors	Diagnosis	Age of participants	Number of participants	Type of health	Title	Outcome
Wallace et al. (2016)	ASD	18 and over	35	Mental health	Real-world executive functions in adults with autism spectrum disorder: profiles of impairment and associations with adaptive functioning and comorbid anxiety and depression	The autistic characteristics measured by the social responsiveness scale were reported by adults with epilepsy to be more severe during their mild seizure activity A variable executive functions profile was found with prominent deficits occurring in flexibility and metacognition. Flexibility problems were associated with anxiety-related symptoms, while metacognition difficulties were associated with depression symptoms and impaired adaptive functioning. These are predictors of broader functioning and therefore remain an important treatment target among adults with ASD
Westwood et al. (2017)	ASD	18 and over	60	Physical and mental health	Clinical evaluation of autistic symptoms in women with anorexia nervosa	Fourteen women (23.3%) scored above clinical cutoff for ASD on the ADOS-2. Only eight of these women displayed repetitive or restrictive behaviours, while all 14 had difficulties with social affect. Elevated ASD symptoms were associated with increased alexithymia and obsessive-compulsive symptoms, but not specific eating disorder pathology

Increased medical comorbidity was associated with female gender and obesity, but not intellectual disability.

Sleep Problems

Baker and Richdale (2017) sought to examine the behavioural sleep-wake rhythm of 36 adults with ASD and assessed them for the prevalence of circadian rhythm sleep-wake phase disorder in comparison to age-matched controls. All participants were asked to complete a 14-day sleep-wake diary which they filled out each morning and evening. It was found that participants with ASD had a higher prevalence of circadian rhythm sleep-wake disorder compared to controls, particularly delayed sleep-wake phase disorder. The results from this study suggested that individuals with ASD have sleep patterns that may be associated with circadian rhythm disturbance. However, factors such as employment status and comorbid anxiety and depression appear to influence their sleep problems.

Similarly, a study by Baker et al. (2017) investigated the association between melatonin and objective sleep parameter measurements and compared adults with ASD, adults with ASD who were medicated for comorbid depression/anxiety (ASD-Med), and controls. The results suggested that medication use for comorbid diagnoses of anxiety and/or depression affected sleep patterns—in fact, melatonin levels were lowest in the ASD-Med group. Overall, when there were greater increases in melatonin in the hour prior to sleep, it was associated with greater sleep efficiency only in the ASD groups.

Furthermore, Limoges et al. (2013) investigated the impact of sleep problems on poor sleep, as measured by attention and memory performance tasks. There was a negative correlation observed between slow-wave sleep and learning a procedural memory task, thus demonstrating the negative influence of sleep problems on performance. The results also indicated that some signs reflecting the presence of poor sleep in adults with high-functioning ASD correlate with various aspects of motor output on nonverbal performance tasks.

Anxiety, Depressive, and Mood Disorders

Croen et al. (2015) carried out a study with a large group of adults with ASD to examine the frequency of psychiatric and medical conditions. The study reported comparable results to Tyler et al. (2011), as adults with ASD had significantly increased rates of all major psychiatric disorders, including depression, anxiety, bipolar disorder, obsessive-compulsive disorder, and suicide attempts. Nearly all medical conditions were significantly more common in adults with ASD, including sleep disorders, seizure, obesity, and diabetes. There were increased risks of immune conditions

and gastrointestinal disorders among men with ASD only, whereas risk of stroke was elevated among women with ASD only.

Helverschou and Martinsen (2011) used screening measures to assess the recognition of anxiety symptoms among adults with ASD compared to controls. The authors note that anxiety can be recognised by symptoms similar to those without ASD. However, signs of physiological arousal seem difficult to recognise in those with ASD, meaning it can be difficult to identify anxiety problems. Additionally, Spain et al. (2016) carried out a study on social anxiety (SA) in males with ASD using self-report measures. This study found that 52% endorsed levels of SA that exceeded the suggested threshold for social anxiety disorder. Analysis indicated that there were no relationships between SA symptoms, present state or childhood ASD symptom severity, or measures of socioemotional processing in this sample. The authors stressed the need to identify mechanisms that lead to the development and maintenance of comorbid anxiety symptoms in adults with ASD.

Wallace et al. (2016) used parental report measures to examine the association between executive function (EF) problems and comorbid anxiety and depression in adults with ASD. Flexibility problems were associated with anxiety-related symptoms, while metacognition difficulties were associated with depression symptoms and impaired adaptive functioning. These persistent problems are predictors of broader functioning and therefore remain an important treatment target among adults with ASD. The influence of EF problems on comorbid anxiety and depression in this sample was also independent of the influence of age, IQ, and comorbid ADHD symptoms.

Other Comorbid Psychopathologies

Furthermore, Westwood et al. (2017) expanded on literature with regard women with ASD and anorexia nervosa. In this study, 23.3% of the women had a diagnosis of ASD, and all had difficulties with social affect. They found that more severe ASD symptoms were associated with increased obsessive-compulsive symptoms but were not specific to an eating disorder. Westwood et al. (2017) elaborates how ASD symptoms can be overrepresented in women with severe anorexia nervosa and can be associated with other psychiatric symptoms.

Wakeford et al. (2015) expands on comorbidity factors in relation to ASD and epilepsy. The results suggest that adults who have epilepsy have higher characteristics of ASD. Interestingly, it was reported that the ASD characteristics were more severe during their mild seizure activity.

Behaviour Problems

Totsika et al. (2010) investigated the relationship between behaviour problems and quality of life in older adults (>50 years) with an intellectual disability (ID) and ASD. This group was compared to a similar-aged group with ID only and younger adults with ID and ASD. The result obtained via questionnaire methods revealed that after accounting for different abilities, older adults with ASD did not differ from those with intellectual disability in terms of behaviour problems and quality of life. However, compared to their younger counterparts, adults with ID and ASD displayed fewer behaviour problems. It is interesting to note that any differences in the skills of adults with ASD were associated with decreased adaptive skills and not the presence of ASD.

General Health Status

Fortuna et al. (2016) examined the general health status of adults with ASD. Cross-sectional data was obtained from a sample of 256 adults with ASD, who varied greatly in terms of age (18–71 years). The authors compared measures of overall health status to those of the general population. The results revealed that in comparison to the general population, adults with ASD experienced a greater prevalence of seizure disorders, depression, hypertension, and allergies. In addition, young adults with ASD, when compared against younger members of the general population, reported lower levels of sexually transmitted infections (STIs), tobacco use, and alcohol misuse. An association was found between depression and lower overall functional status. Finally, the authors found that the majority of their adult ASD sample required at least some assistance with daily living—only 43.1% were independent with bathing.

Khanna et al. (2014) also examined the health status of adults with ASD but focused on their health-related quality of life (HRQOL). The authors sought to compare the HRQOL of adults with ASD to the general population and determine factors associated with HRQOL in this population. A cross-sectional online survey was designed to investigate this, and the final sample included 291 adults with ASD. Compared to the general population, results revealed that adults with ASD have significantly lower physical and mental HRQOL than those without ASD. The physical and mental HRQOL of adults with ASD also varied in terms of medical history—those who reported having other physical illnesses reported lower physical HRQOL than those who did not.

Finally, Vogan et al. (2017) investigated a diverse range of medical and mental health services and supports, as well as adults' personal experiences accessing and using these services, and barriers to service use. Participants completed self-report measures every 2 months for a total of 12–18 months. Results indicated that the most commonly used

services were dentistry and psychiatry. It can also be noted that individuals who had medical problems experienced significantly more barriers to service use than those who did not. Additionally, adults with medical problems reported less satisfaction with services than those who did not report medical problems.

Discussion

This systematic review examined the different aspects of health status among adults with ASD across 21 studies published between the search period. Findings suggested that the most common medical conditions in adults with ASD were epilepsy, obesity, insomnia, and constipation. Interestingly, research has found that the median number of medical conditions per person was 11 conditions (Jones et al., 2016). This is surprisingly high, given that individuals who had medical problems experienced significantly more barriers to service use than those who did not have a diagnosis.

A number of studies focused on the medical conditions in relation to men and women with ASD. For instance, Tyler et al. (2011) and Croen et al. (2015) found similar results, showing that the rates of chronic disease included 34.9% for obesity in one study and nearly all medical conditions were significantly more common in adults with ASD, including immune conditions, gastrointestinal and sleep disorders, seizure, obesity, and diabetes. In other cases, such as Chen et al. (2016), it was found that young adults had a higher risk of developing type 2 diabetes than those without ASD.

Research has evidenced a connection between sleep problems and adults with ASD. Common sleep problems reported among those with ASD have included difficulty falling asleep, irregular sleep patterns, and daytime sleepiness (Richdale & Schreck, 2009). The research found is consistent with these reports, with Baker and Richdale (2017) finding that greater ASD symptom severity was associated with disrupted circadian rhythms. Importantly, there were also common barriers to high-quality sleep identified in the literature. For example, comorbid depression and anxiety appeared to negatively impact sleep quality (Baker & Richdale, 2017). It also bears noting that factors such as employment status, which were found to influence sleep patterns, are unique to the adult ASD population (Baker & Richdale, 2017). Although it became clear that the majority of studies within the literature have focused on the child ASD population, future research examining the connection between sleep problems and adults with ASD is warranted, given the unique challenges faced by the adult population.

As the presence of a comorbid medical condition or mental disorder deeply affects the daily lifestyle of an individual and their overall health status (Avni et al., 2018), this review sought to understand the impact of comorbidity in ASD life

outcomes in adulthood. The findings of this review demonstrate a range of maladaptive outcomes for adults with ASD who experience comorbidities and a greater need for services to support this subsection of the population. Both Wallace et al. (2016) and Fortuna et al. (2016), for instance, found that comorbid health-related deficits were associated with impaired adaptive living skills, such that many adults require assisted living to manage their comorbid conditions (Fortuna et al., 2016).

The impact of comorbidity can also be seen in the resulting manifestation of adverse health outcomes—take, for example, the finding from Jones et al. (2016) that medical comorbidity is associated with obesity. Adding to this conclusion is the finding from Khanna et al. (2014) that having other physical illnesses results in a comparatively worse physical HRQOL. Furthermore, comorbid diagnoses can impact the presentation of additional problems, as was found by Baker et al. (2017) in relation to the impact of comorbid depression/anxiety on sleep patterns. Clearly, then, adults with ASD who also experience medical comorbidities are in greater need of supportive measures to help mitigate the impact of their conditions on their everyday life.

It is equally necessary to identify behavioural factors that influence health status among adults. Wallace et al. (2016), for instance, carried out a study involving high numbers of participants who also had severe depression and/or anxiety disorders. There was an association made between behaviour problems of adults with ASD and their health status in comparison to those with an intellectual disability. The results suggested that the only difference was a decrease in adaptive skills in those with ASD. Greater insight into behavioural problems may be necessary for further research, which may contribute to our understanding of the health status of adults with ASD.

This review synthesised the findings from a large body of literature concerning the health status of adults with ASD. As the findings pertaining to comorbid conditions associated with ASD are typically examined in isolation from one another, and few attempts have been made to date to collate this knowledge, this review provides an accessible means to inform researchers and care providers of the health challenges faced by adults with ASD. Another key strength of this review is that it included only studies whose participants had received a valid diagnosis of ASD, which translates to a high level of clinical significance.

This systematic review was limited in a number of ways. The decision to include all studies that examined the health status among adults with ASD, regardless of experimental design, means that there was a large amount of variance in the sample sizes of the studies that were examined. Of the 21 studies included in this review, five studies featured sample sizes lower than 50. However, given the number of research studies published, it helped to provide a comprehensive

discussion of this topic. Nevertheless, this necessarily calls into question the external validity of the studies in which fewer than 50 participants were included, as their findings may not generalise to the entire adult ASD population. There is a pressing need for replication, therefore, with larger sample sizes, as this could allow researchers to detect effects that would otherwise be missed in a smaller sample.

This systematic review has explored the recent literature concerning the health status of adults with ASD, a population to which far less research has been devoted in comparison to childhood ASD. Moving forward, the adult ASD population is deserving of greater research attention so as to enrich our understanding of the health-related challenges they face. In particular, further examination of the interactions between “normative” outcomes (such as employment and independent living) and “objective” measures of health (i.e. physical and mental health), as described by Bishop-Fitzpatrick et al. (2016). Many barriers and facilitators to good health do not become relevant until adulthood. A deeper understanding of the way in which these aspects of everyday life interact with the conditions which are comorbid with ASD is crucial to improving the lives of adults with a diagnosis of ASD. This can only be achieved with the input of adults with ASD themselves.

Adults with ASD, compared to adults without ASD, have a greater probability of living with multiple, comorbid conditions which may severely impact their physical and mental wellbeing. This review has highlighted a multitude of health conditions, both physical and mental, which have a high degree of prevalence among the adult ASD population. This review has also highlighted the impact of comorbidity in ASD on life outcomes in adulthood. The most common physical health complaints related to immune system, GI symptoms, sleep, and epilepsy, while mood and anxiety disorders and OCD were the most frequently reported mental health challenges across studies. Moving forward, it is imperative to investigate further the unique challenges faced by adults with ASD; not only are interesting insights likely to emerge, but this work can also be used to develop interventions specifically tailored to adults.

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Declarations

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

Conflict of Interest The authors declare no competing interests.

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