Research in Autism Spectrum Disorders 63 (2019) 23–33

Contents lists available at ScienceDirect

Research in Autism Spectrum Disorders

journal homepage: www.elsevier.com/locate/rasd

A meta regression analysis of quality of life correlates in adults with ASD

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ARTICLE INFO

Keywords:
Adults
Autism spectrum disorder
Quality of life
Meta-analysis
Social functioning
Correlates

ABSTRACT

Background: In this meta-regression analysis, we investigated Pearson's *r* correlations between Quality of Life (QoL) and several putative correlates, including (a) age, (b) intellectual quotient (IQ), (c) autism severity, and (d) social functioning (SF).

Method: Robust variance estimation was used to synthesize the effect sizes from published and unpublished studies/datasets. One hundred sixty five effect sizes (extracted from 17 studies/datasets) comprising a total of 1721 participants with ASD (mean age = 35.64 years; mean percent male = 62.24%) were retrieved.

Results: Summary effect sizes derived from unconditional meta-regressions for the association between QoL and age, IQ, and autism severity were close to zero and statistically insignificant. In contrast, the summary effect size for the association between QoL and social functioning was statistically significant and moderately sized.

Conclusion: Of the correlates we examined, only social functioning appears to bear significant summary-level associations with QoL. Improvements in social functioning may enhance QoL in adults with ASD. Alternatively, interventions aimed at neurotypical populations that promote ASD acceptance may lead to increased QoL that is not dependent on social functioning. Factors other than normative adult outcomes that may influence adult QoL should be explored.

1. Introduction

According to Schalock (2004), quality of life (QoL) is a comprehensive phenomenon that includes subjective and objective well-being in domains such as interpersonal relations, social inclusion, personal development, physical well-being, self-determination, material well-being, emotional well-being, and rights. The World Health Organization (WHO) provides a definition with more emphasis on subjective appraisal, indicating that QoL is "an individual's perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" (WHOQoL, 1997, p.1). Both Schalock's (2004) and the WHO's (1997) definitions concur that QoL is influenced by personal characteristics and environmental variables. QoL theorists assume that all humans have similar desires and needs in various domains, and appropriate support services should be provided for each person to reach his/her optimal potential (Schalock, 2004).

In general, prior research has suggested lower QoL in adults with autism spectrum disorder (ASD) compared to the neurotypical population (Chiang & Wineman, 2014; Jennes-Coussens, Magill-Evans, & Koning, 2006; Mason et al., 2018; Moss, Mandy, & Howlin, 2017; Van Heijst & Geurts, 2015). Moreover, Marriage, Wolverton, and Marriage (2009) suggest even individuals with ASD who have low support needs often do not achieve adult outcomes that are expected given their cognitive abilities. Adult ASD outcomes such as

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https://doi.org/10.1016/j.rasd.2018.11.004
Received 30 April 2018; Received in revised form 31 August 2018; Accepted 7 November 2018

QoL are thought to be highly dependent on contextual and individual factors, such as the severity of ASD diagnosis, mental health, intellectual and language ability, the quality of parent-child relationships, and inclusion in school activities (Howlin & Matiagi, 2017). While there is growing interest in factors that are associated with QoL in adults with ASD, there is no consensus on what these factors might be (Howlin & Matiagi, 2017; Zimmerman, Ownsworth, O'Donovan, Roberts, & Gullo, 2018). To fill this gap, this systematic review and meta-regression analysis will examine the association between QoLin adults with ASD and several putative correlates including age, IQ, autism severity, and social functioning. These correlates were selected because prior research suggests that they may be important for QoL, and because we expected that these correlates would be sufficiently represented in existing research to conduct meta-analyses.

1.1. Research on putatitive correlates of QoL

1.1.1. Age

Although autistic symptoms, maladaptive behavior, and sensory issues are known to show modest improvement with age (Esbensen, Seltzer, Lam, & Bodfish, 2009; Happé & Charlton, 2012; Kern et al., 2006; Shattuck et al., 2007), several researchers have found insignificant relationships between age and QoL (Chiang & Wineman, 2014; Kamio, Inada, & Koyama, 2013; Kamp-Becker, Schroder, Remschmidt, & Bachmann, 2010; Van Heijst & Geurts, 2015). Recently, Mason et al. (2018) reported that QoL was higher in younger adults as compared to older adults with ASD, but this finding was restricted to psychological and environment domains. In contrast, a meta-analysis by Van Heijst and Geurts (2015) showed that age was not significantly associated with QoL in individuals with ASD, although this study was not limited to adults and did not include grey (unpublished) literature, which may have led to imprecise estimates.

1.1.2. Intelligence

There has been some literature examining the association between intelligence and QoL. This research has been mixed; several studies have shown insignificant associations between IQ and QoL in adults with ASD (Billstedt, Gillberg, & Gillberg, 2011; Kamp-Becker et al., 2010; Renty & Roeyers, 2006). While Howlin, Goode, Hutton, and Rutter (2004) reported that IQ scores were positively associated with adulthood outcome in terms of objective level of education attainments and employment, Moss et al. (2017) found that adults with higher IQ reported lower QoL. It is possible that individuals with individuals with higher cognitive skills are more aware of their feelings of dissatisfaction, resulting in lower QoL. On the other hand, because adults with higher IQ scores tend to have had better academic success, and are more likely to secure employment than adults with lower IQ scores (Howlin & Matiagi, 2017; Howlin et al., 2004), they may report better overall QoL.

1.1.3. Autism symptom severity

Research has also been inconsistent in detecting associations between QoL and autism severity (Chiang & Wineman, 2014; Howlin & Matiagi, 2017; Kamio et al., 2013; Moss et al., 2017). Autism severity is frequently determined by the extent of support needs in the two core domains of ASD symptoms; difficulty in social interaction and communication, and restricted and repetitive behaviors or interests (American Psychiatric Association, 2013). A few studies have shown no associations between QoL and composite scores of autistic symptoms (e.g., Chiang & Wineman, 2014; Kamp-Becker et al., 2010; Saldaña et al., 2009). However, Moss et al. (2017) found that QoL in adulthood was significantly negatively correlated with the severity of restricted and repetitive behaviors in childhood, and Mason et al. (2018) reported total autism severity was a significant negative predictor of QoL across several domains, including social, environmental, physical, and psychological. Because adults with more autism symptoms reported more limited independence and social relationships and greater difficulty with employment than adults with fewer autism symptoms (Helles, Gillberg, Gillberg, & Billstedt, 2017; Howlin & Matiagi, 2017), symptoms specifically associated with ASD may be related to QoL in adults with ASD.

1.2. Social functioning

Tobin, Drager, and Richardson (2014) proposed a QoL framework that integrates social functioning into Schalock's model of QoL. Recently, Leader, Grennan, Chen, and Mannion (2018) found a significant correlation between QoL and how adults with ASD perceive their social functioning in terms of maintaining relationships with others and feeling isolated and lonely. Several large-scale studies on individuals with other disabilities such as Down syndrome (van Gameren-Oosterom et al., 2011), and a broad spectrum of psychiatric disorders (Trompenaars, Masthoff, Van Heck, De Vries, & Hodiamont, 2007) have demonstrated that social functioning is associated with QoL. Esbensen et al. (2009) reports restricted and repetitive behaviors often decrease when individuals with ASD age into adulthood, but social difficulties have been reported to be stable over time (Seltzer et al., 2003). Finally, social functioning is often a point of intervention for adults with ASD, which suggests that there is an implicit assumption on the part of practitioners that enhancing social functioning will improve QoL (Strain, 2001). Because of these factors, we thought it worthwhile to examine social functioning separately from overall autism severity.

1.3. Potential moderators of associations between putative correlates and QoL

In addition to determining summary effect sizes for the association between QoL and the four putative correlates described above, we were also interested in exploring whether sample characteristics, including age and the percentage of male participants,

moderated effect sizes. Age could moderate associations between QoL and IQ, autism severity, and social functioning because increased autism severity lower intellectual ability could have greater influences on QoL in older as compared to younger adults because expectation around employment and independent living (features of QoL) might be higher in older as compared to younger adults. Younger adults may also have greater support from family than older adults, which could decrease the impact of IQ, autism severity, and social functioning on QoL.

Gender could also be an important moderator of effect sizes. Recently, several studies have identified gender differences in the manifestation of autism severity, and suggest that women may be more likely to camouflage their autistic symptoms than are men. This may result in women receiving scores that indicate fewer symptoms on diagnostic tests such as the Autism Diagnostic Observation Schedule (ADOS) (Lai et al., 2017). However, this could be an artificial inflation of ADOS scores, and could result in women getting less support than they actually need. If this were the case, we would expect associations between both autism severity and QoL and social functioning and QoL to be attenuated in women as compared to men.

1.4. The current study

In sum, existing research on potential correlates of QoL are contradictory and remain uncertain (Jonsson et al., 2017). Because improving QoL is one of the main objectives in various interventions and social services for adults with ASD (Hong, Bishop-Fitzpatrick, Smith, Greenberg, & Mailick, 2016), it is important to identify factors associated with QoL to develop appropriate supports for adults with ASD. Currently, there is no quantitative synthesis that would aid in sorting through these disparate findings. Using a systematic review and meta-regression framework, this study will address the following research questions:

1 Are age, IQ, and social functioning significantly and positively associated with QoL, and is autism severity negatively associated with QoL?
2 Do sample features, including chronological age and percentage of male participants in the sample moderate effect sizes? We considered these analyses to be exploratory.

2. Method

2.1. Search strategy

A systematic literature search was conducted in August 2017 on Medline, PsycINFO, PubMed, ERIC, and ERC and ProQuest Dissertations & Theses to retrieve published studies that reported on the QoL of adults with ASD. The search fields included the title, abstract, and main text, and the search was conducted within each of the above-mentioned individual search engines with limiters including publication after 1970, and published in English. Different combinations of the following search terms were used to identify the studies: autis* OR autism spectrum disorder OR autistic disorder OR Asperger OR Pervasive developmental disorder not otherwise specified (PDD-NOS) AND adult* AND quality of life OR age OR severity OR IQ OR intellectual impairment OR social. The search identified several review articles; backward and forward searches were conducted on these to identify additional articles. The reference librarian at the authors' institution was consulted during the structured search process. The main structured search was not limited to "peer-reviewed only," so abstracts and articles from unpublished journals and conferences were included in the initial batch of retrieved studies. Then, hand searches of *Autism, Autism Research*, and the *Journal of Autism and Developmental Disorders,* were also conducted to locate additional articles. Finally, an additional grey literature search was conducted using five recent online conference proceedings for the International Meeting for Autism Research (2012–2017). We generated a list of experts by searching these proceedings, and these experts were then contacted by email to determine if they would be willing to share any unpublished findings that met our inclusion criteria. Only the five most recent online proceedings were searched because we expected this timeframe would yield researchers with readily accessible data to share. This process yielded a list of twenty researchers, excluding those who had already been contacted by the first author as part of our main search. These researchers were contacted via email to request unpublished findings that met to our inclusion criteria (indicated below).

Mendeley was used to organize references and abstracts, and locate and merge duplicates. Titles and abstracts were then subject to an initial screening to remove those that were clearly not relevant to the search. Subsequently, the remaining articles were read in full and independently coded by the first author and a graduate level research assistant independently. The inclusion criteria were the following: 1) published in English, 2) published after 1970, 3) included a Pearson's *r* correlation between a self-report or other-report measure of partial or overall QoL, and one of the four correlates of interest (age, IQ, autism severity, or social functioning); and 4) included participants with a primary diagnosis of ASD who were 18 years old or older (diagnoses could include comorbid symptoms). We chose Pearson's *r* as the effect size of interest because we expected that it would be the most commonly reported. The corresponding authors of studies that measured our constructs of interest, but did not include Pearson's *r* correlations (i.e. those who only reported Spearman's rho) were contacted to request this information. Also, authors of the studies that included participants less than 18 years of age were contacted to request correlations calculated from the sub-sample of participants aged 18 or above.

In August 2018, a follow-up search was conducted to locate studies or unpublished datasets that became available after our initial search. The same set of procedures described above was used to identify the articles/datasets. See the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram depicted in Fig. 1 for our process of locating the studies.

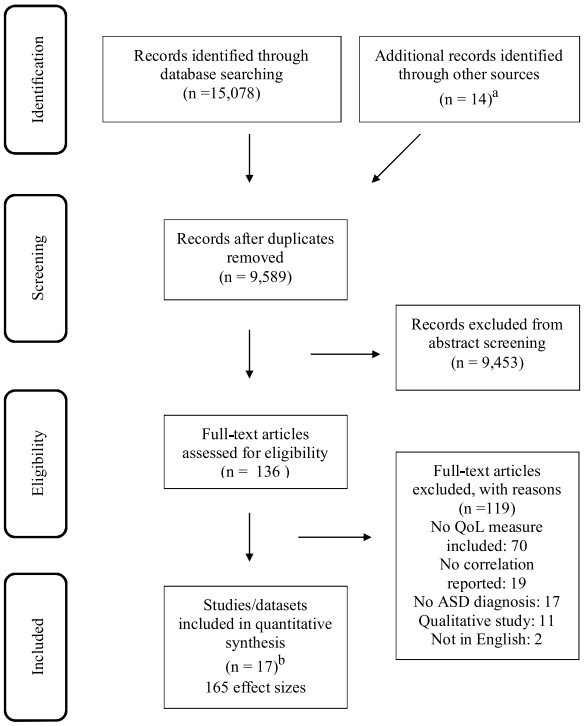

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram.
Note. This diagram includes the results from two sets of structured search and grey literature search procedures (August 2017 and August 2018). a. In August 2017, authors of 22 published articles and 20 experts identified from INSAR proceedings were contacted, 12 responded requested data. Additionally, in August 2018, authors of 5 published articles and 12 experts identified from INSAR 2018 proceedings were contacted, and we received 2 datasets. b. Among these, 3 reports come from published data, and 14 datasets/studies are collected from personal email correspondence from the authors.

2.2. Coding protocol

The first author and a graduate level research assistant independently coded all included articles and data sent via email to extract the following variables: sample size, IQ, publication year (or, if the data were unpublished, the year of publication of the manuscript associated with the dataset), chronological age, procedure to confirm diagnosis, percent male, the direction of effect if the study was longitudinal (i.e., if social functioning was measured before or after the correlate of interest), time to follow-up in months if the study was longitudinal, type of measures used to assess QoL, autism severity, social functioning, and the value of the Pearson's *r* for the associations between QoL and the four correlates of interest: (a) age, (b) IQ, (c) autism severity and, (d) social functioning. Because the majority of the data for this meta-analysis was extracted from unpublished data shared with the authors via email, email correspondence was also coded to assure reliability in extracting information from these sources. Correlations with autism severity and social functioning were reverse coded, because higher scores on these measures correspond to more severe symptomatology. The definitions of the variables the coders used to code the data are as follows:

(a) QoL: Self-reports or other-reports that were directly specified to measure QoL. Correlations calculated from subdomains of QoL measures (e.g., physical wellbeing domain of WHOQoL) were included in addition to correlations calculated from composite QoL scores, if available.
(b) Chronological Age: Age in months
(c) Intelligence quotient (IQ): A total score derived from several standardized tests designed to assess human intelligence. Either full scale or verbal IQ was accepted.
(d) Autism severity: This construct was measured by a composite score that included both the social interaction/communication and the restricted and repetitive behaviors or interests domains (American Psychiatric Association, 2013).
(e) Social communication and interaction: Difficulty in social-emotional reciprocity, verbal and nonverbal communicative skills and behaviors, and developing and maintaining relationships (American Psychiatric Association, 2013)
(f) Restricted and repetitive behaviors or interests: Inflexibility of behavior causing difficulty switching focus or actions, organizing planning or presence of restricted/repetitive behaviors that markedly interfere with functioning (American Psychiatric Association, 2013)
(g) Social functioning: This construct includes the ability to develop and maintain social emotional reciprocity and interpersonal

relationships with others, engage in socially adaptive behavior, refrain from problem behavior. Subdomains separated out of a diagnostic instrument (e.g., Reciprocal Social Interaction domain from ADOS-2), and instruments measuring problem behavior were included.

Coders agreed on inclusion/exclusion decisions 100% of the time. For continuous variables, the average ICC from two-way random effects models was 0.86 (range 0.74–0.95). The ICC for Pearson's *r* was 0.96. For categorical variables, the average Kappa coefficient was 0.85 (range = 0.83–0.87). Inter-coder agreement can therefore be considered good for all coding categories.

2.3. Statistical procedures

A series of meta-regressions were conducted, with Pearson's *r* effect sizes for the association between QoL and each correlate of interest as the dependent variable. All calculations were performed using the transformed Fisher's z value of Pearson's *r*, which were converted back to Pearson's *r* correlations for reporting results (Borenstein, Hedges, Higgins, & Rothstein, 2009).

Because the majority of studies/datasets contributed more than one effect size to the meta-regression, the assumption of independence that is required of traditional meta-analytic statistical procedures is violated (Hedges, Tipton, & Johnson, 2010). Therefore, we employed a robust variance estimation (RVE) approach with random weights to account for the clustering of effect sizes within studies, using the ROBUMETA macro in Stata (StataCorp, 2017).

To address our first research question, unconditional meta-regression models were conducted separately for effect sizes representing associations between QoL and each putative correlate (age, IQ, autism severity, social functioning) to calculate summary effect sizes. Unconditional meta-regression models estimate synthesized effect sizes without including covariates as moderators. These results were then depicted in forest plots, which include the summary effect point estimate as well as the confidence intervals around the estimate.

To address our second research question, we conducted a set of simple meta-regression models with putative moderators (chronological age and percentage of male participants) of effect sizes entered as a covariate. For analyses conducted on the association between QoL and age, only percent male was examined as a moderator. Both mean chronological age and percentage of male participants showed skewed distributions, and were therefore log- transformed and squared, respectively, prior to analysis. Source (published or unpublished), IQ, direction of effects, and time to follow-up were not included as moderators because there were either an insufficient number of studies within each category, or there were an insufficient number of studies that reported scores on the variable (i.e., < 5). For example, because only three published report contributed to the meta-analysis, it was not possible to examine source as a moderator, which would have given information about publication bias. However, given that the majority of our data were collected from unpublished sources, we do not believe our findings are over-estimates of effects, which can be a concern when synthesizing published literature.

Finally, a set of unconditional meta-regression models were conducted as sensitivity tests to determine if there were differences in summary effect sizes when studies that used 'other' reports of QoL (as opposed to self-reports) were excluded from the analysis. We conducted these sensitivity tests because Hong et al. (2016) suggested that although closely related, 'other' reports show different patterns as compared to self-reports, especially in social relationship domains of QoL.

3. Results

The meta-analysis was conducted on a total of 165 effect sizes (17 studies/datasets, three of which were published), comprising a total of 1721 adults with ASD (mean age = 35.64 years; range = 18–63.6; mean percent male = 62.24%). IQs were available from six datasets, and they ranged from 36.9 to 112.2. Each dataset contributed an average of 9.70 effect sizes. See Table 1 for participant and study characteristics.

Sixteen studies/datasets only included self-reports of QoL. Eight studies/datasets measured QoL using subdomains of the World Health Organization Quality of Life Assessment (WHOQOL)-BREF, and effect sizes calculated from these subdomain scores were included if available. This measure also includes a 'global QoL' score and a 'health-related QoL score, but these are derived from a single question on the measure ('How would you rate your quality of life?' and 'How satisfied are you with your health?'). When correlations computed from these questions were provided, these effect sizes were included along with the correlations calculated from domain scores. Only one study provided effect sizes computed from global and/or health QoL scores without also providing correlations calculated from domain scores. Including these multiple correlations was allowed because the RVE procedures we used

Table 1
Participant and Study Characteristics.

Participant/Study Features	*M* (*SD*)
% male	62.24 (17.42)
Year published	2014.71 (3.48)
Chronological age at T1 (years)	35.64 (11.32)
Time to follow-up[a] (months)	3.78 (15.21)
Sample size	101.24 (112.34)

[a] Months between measurement of QoL and putative correlates.

Table 2
Characteristics of Studies/datasets Included in the Meta-Analysis.

Author (year published)	Sample Characteristics					Correlates with QoL (number of effect sizes)				
	n	IQ Mean, (SD or range)	% male	Diagnostic Criteria used to Confirm Diagnosis	CA	Age	IQ	AS	SF	QoL Measure: subdomains used for calculation of correlations
Bishop-Fitzpatrick,Mazefsky, and Eack (2018)	40	106.5 (15.33)	70.0	ADOS, ADI-R	24.20 (6.95)	4	4		8	WHOQOL-BREF[c]
Dijkhuis, Zierman, Van Rijn, Staal, and Swaad (2017)	85	HF	88.3	CC	22.0 (2.3)	1			1	QoL-Q[d]
Gerber et al. (2011)[a]	29	ID	74.2	CC, CARS	39.7 (10.5)			2	8	Quality of Life Inventory in a Residential Environment (Tremblay & Martin-Laval, 1997) [d]
Helles et al. (2017)	39	97.0 (N/A)	100	CC	30.8 (5.3)	2	2	2		Medical outcome study Short-Form Health Survey version 2.0 (SF-36v2): Physical and mental
Hesselmark, Plenty, and Bejerot (2014)	60	N/A	56.5	ADOS	31.8 (9.0)	1				Quality of Life Inventory (QOLI; Frisch et al., 1992)[d]
Hong et al. (2016)	60	N/A	76.7	ADI-R, SRS	31.5 (6.8)	4		4	4	WHOQOL-BREF[c]
Jennes-Coussens et al. (2006)	12	Childhood Verbal IQ = 36.92 (21–54)	100	CC, Ehlers and Gillberg checklist (1993)	20.3 (4.6)	6	6			WHOQOL-BREF: global QOL question and general health question WHOQOL-BREF[c]
Kamio et al. (2013)[b]	154	HF	79.9	CC	27.6 (6.5)	1				WHOQOL-BREF: Psychological health and social relationships
Khanna, Jariwala-Parikh, West-Strum, and Mahabaleshwarkar (2014)	291	N/A	60.8	ADOS-2, SCQ	30.8 (11.9)	2		2		Short-Form Health Survey (SF-12v): Physical and mental
Leader et al. (2018)[b]	103	N/A	35.9	AQ	37.0 (12.4)				1	WHOQOL-BREF: global QOL question
Lin (2014)	41	> 70	73.2	CC	26.9 (5.0)	4	4			WHOQOL-BREF[c]
Mason et al. (2018)	370	N/A	53.8	SRS	42.0 (14.4)	4		4	8	WHOQOL-BREF[c]
McConachie et al. (2018)	309	N/A	48.2	SRS	43.0 (13.8)	10		10		WHOQOL-BREF[c] WHOQoL-DIS[c] ASQoL: Total and global subdomain
Moss et al. (2017)[a]	50	69.9 (20–139)	82.7	ADI-R	47.9 (9.5)	12	12	12	12	WHOQOL-BREF: Global QOL question and general health question WHOQOL-BREF[c]
Saldaña et al. (2009)	24	N/A	85	N/A	24.6 (5.8)	1		1		Comprehensive Quality of Life Questionnaire (ComQol: Cummins, 1997)[d]
Van Heijst and Geurts (2015)	24	109.5, (10.3)	79.2	SRS-A, CC	63.7 (7.4)	1	1		1	SAND-36 (Van der Zee & Sanderman, 1993)[d]
White et al. (2018)	30	Verbal IQ = 112.2 (15.16)	66.7	ADOS-2, SCQ	21.3 (3.3)	1	2			QoL-Q[d]

Note. AS = autism severity; SF = Social functioning; CA = Chronological age (in year). CC: diagnosis via clinical consensus from registered psychiatrists or psychologists. CARS = Childhood Autism Rating Scale (Schopler et al., 1988). ADOS = Autism Diagnostic Observation Schedule (Lord et al., 2000). ADI-R = Autism Diagnostic Interview-R (Lord et al., 1994). SRS-A = Social Responsiveness Scale Adult (Noens et al., 2012). SCQ = Social Communication Questionnaire-Lifetime (Rutter et al., 2003). HF = IQ not reported but participants are labeled as "high-functional ASD" in the paper. ID = IQ not reported but participants have intellectual disability. QoL-Q = Quality of Life Questionnaire (Schalock & Keith, 1993). N/A = not available or not reported. SD = standard deviation.

[a] Includes 'other' reports.

[b] Peer-reviewed article that included the Pearson correlation values of interest in the paper. The rest of the articles did not include the actual value in the paper but was related to the datasets retrieved from email correspondence.

[c] Correlations were calculated individually with scores from environmental, psychological, social relationship, and physical health subdomain of WHOQoL-BREF.

[d] Composite total score of QoL was used in calculation of the correlations.

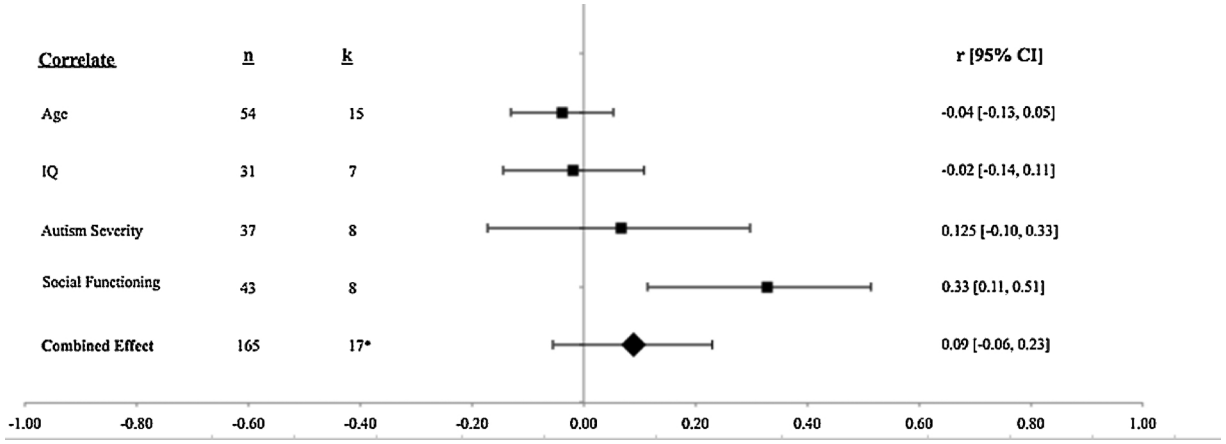

Fig. 2. Forest Plot of Summary Effect Sizes for the Pearson's r Association between QoL and (a) Age, (b) IQ, (c) Autism Severity, and (d) Social Functioning.

Note. n = the number of effect sizes included in each unconditional regression, k = the number of studies included in each unconditional regression, *The number of n of the summary effect does not add up to the n of age, IQ, autism severity and social functioning because majority of studies contributed more than one effect sizes.

for synthesizing effect sizes accounts for multiple effect sizes from a single dataset. The Quality of Life Questionnaire (QoL-Q; Schalock & Keith, 1993), Comprehensive Quality of Life Questionnaire (ComQol; Cummins, 1997), RAND-36 (Van der Zee & Sanderman, 1993), Quality of Life Inventory in a Residential Environment (Tremblay & Martin-Laval, 1997), and Quality of Life Inventory (QOLI; Frisch, Cornell, Villanueva, & Retzlaff, 1992) were originally designed to provide overall QoL scores, so effect sizes from these measures were computed from this single composite score.

Of the 7 studies that reported correlations between IQ and QoL, 5 studies used a clinician's assessment using either the verbal IQ or the full scale IQ of the Wechsler Adult Intelligence Scale (WAIS-III). In terms of procedures to measure autism severity, autism diagnostic instruments such as the Autism Diagnostic Observation Schedule (ADOS), the Autism Diagnostic Interview-Revised (ADI-R), the Childhood Autism Rating Scale (CARS), Ehlers and Gillberg (1993) checklist, the Autism Spectrum Quotient-10 (AQ-10), or the Asperger Syndrome Diagnostic Interview (ASDI) were utilized. The reciprocal social interaction subscale of the ADI-R, ADOS-2, the Social Responsiveness Scale (SRS), and Aberrant Behavior Checklist (ABC) were used to measure social functioning. A detailed description of all retrieved studies/datasets is presented in Table 2.

The summary effect size for Pearson's correlations generated from the unconditional models for associations between QoL and age, IQ, and autism severity were close to zero and statistically insignificant. In contrast, the summary effect for the association between QoL and social functioning was statistically significant ($p < 0.001$), positive, and in the moderate range ($r = 0.33$). Forest plots for summary effect sizes are presented in Fig. 2.

Neither percent male nor chronological age moderated effect sizes for any of the associations with QoL. Results from meta-regressions to examine moderator effects for each of the four correlates are presented in Table 3.

Lastly, computing summary effects after removing one dataset that measured QoL using an "other" report measure did not change results. The summary effect for the association between QoL and autism severity remained insignificant, and the summary effect for the association between QoL and social functioning remained significant.

Table 3
Simple Regression Coefficients For Moderators of Effect Sizes Between QoL and 4 Putative Correlates.

Putative QoL Correlate	Moderator	Coefficient	Standard Error	95% CI
Age	% male	0.00	0.003	[−0.006, 0.007]
IQ	% male	0.006	0.004	[−0.007, 0.019]
	Chronological Age	0.00	0.00	[−0.001, 0.001]
Autism Severity	% male	−0.009	0.006	[−0.028, 0.010]
	Chronological Age	0.002	0.001	[−0.001, 0.005]
Social Functioning	% male	−0.009	0.006	[−0.033, 0.015]
	Chronological Age	0.00	0.00	[−0.001, 0.002]

Note. *$p < 0.05$.

4. Discussion

4.1. Associations between QoL and putative correlates

Our central aim was to compute synthesized effect sizes for the associations between QoL and four putative correlates; (a) age, (b) IQ, (c), autism severity, and (d) social functioning in adults with ASD, using a meta-analysis framework. Analyses failed to detect associations between QoL and age, IQ, or autism severity, but did detect a significant and positive association between QoL and social functioning. The insignificant association between QoL and age is consistent with findings from a previous meta-analysis that included both children and adults with ASD (Van Heijst & Geurts, 2015). While some of the single studies that we included did report significant effects between QoL and IQ (e.g., Moss et al., 2017), and between QoL and autism severity (Mason et al., 2018), these effects were attenuated when all of the available literature was used to compute synthesized effect sizes.

While Howlin et al. (2004) argued that autism symptomatology may have more predictive value in explaining QoL as compared to demographic characteristics such as age and IQ, we did not find this to be the case. However, social functioning considered on its own (i.e., separated out from autism severity) *was* found to bear moderate associations with QoL. It could be that individuals with ASD with higher social functioning experience less stigma and prejudice and consequently have better chances of achieving milestones associated with adulthood, such as locating and retaining a job, or developing and maintaining satisfying relationships.

An interesting point to consider is the role of 'camouflaging' on social functioning, which may impact quality of life. Camouflaging has been a topic of interest for researchers and for autistic adults in recent years. Hull et al. (2017) showed that adults with ASD often engage in camouflaging behavior with explicit techniques to suppress or control autistic behaviors and to assimilate into neurotypical social norms. These efforts would likely lead participants to score more highly on social functioning measures such as those used by the studies included in this meta-analysis. Although participants in prior studies have reported that camouflaging efforts helped with the attainment of short-term goals such as securing employment or graduating, they also frequently reported exhaustion, discomfort, and stress from the continuous effort to mask their true identity. Considered together with our results, individuals with ASD may be calculating the QoL benefits that can accrue from choosing to camouflage, and contrasting these with the significant penalties for not camouflaging (e.g., lack of employment, decreased independence, fewer social networks, etc.). Therefore, while camouflaging may result in the considerable long-term mental health costs described above, an inability or decision not to camouflage may result in even greater loss of QoL. Researchers and practitioners should consider this double bind when promoting social functioning as an avenue for enhancing QoL.

It could be that changing societal expectations about social functioning, so that QoL domains could be achievable regardless of social functioning levels, could be a more productive and sustainable approach to enhancing QoL in adults with ASD than interventions aimed at improving social functioning. When considering social functioning, both the social abilities of those with ASD and the perceptions and judgments of those without ASD should be considered as factors influencing the quantity and quality of social interaction (Mitchell, 2015; Sasson & Morrison, 2017). Increasing awareness and acceptance on the part of neurotypical individuals and reducing negative stereotypes that contribute to the stigmatization of individuals with ASD may be an important means for improving social functioning in ASD, which may lead to improvements in QoL. At the very least, altering neurotypical perceptions should be done in tandem with social functioning interventions.

4.2. Moderators of associations

We did not detect significant effects for either percentage of male participants or chronological age. This suggests that, at least for these two demographic characteristics, the association between correlates and QoL is consistent across different ages and the percent of male participants. Although we did not directly test differences between men and women, we infer that a significant moderator effect of the percentage of male participants would emerge in possible places where men and women differ. If there were gender differences (i.e. age and QoL are more highly correlated in men as compared to women), we would expect that percentage of male participants would be a significant moderator of the association.

It is possible that other sample characteristics that we were unable to test in this analysis because they were not reported, such as SES or race/ethnicity, do moderate summary effect sizes. Even if these demographic features are not the constructs of interest that researchers aim to test in regards to QoL, researchers should still take care to report these sample characteristics. This would allow for a better understanding of the populations to which results can be generalized, as well as allow future meta-analyses to test these variables as potential moderators.

4.3. Considerations for future research

Taken together, our findings offer only a partial explanation for variation in QoL in adults with ASD. Social functioning, while moderately correlated with QoL, only explains approximately 10% of the variance (which can be computed by squaring the correlation effect size). Therefore, other factors that we were unable to analyze in the present study likely play a role in QoL. Toward this end, it is worth noting other QoL correlates that have been reported in prior research (but not in sufficient quantity to synthesize via meta-analysis). We provide a table of such research in the supplementary material. For example, previous research has shown that QoL is significantly correlated with psychological factors such as perceived stress (Bishop-Fitzpatrick, Smith, Greenberg, & Mailick, 2017), self-esteem (Pearlman-Avnion, Cohen, & Eldan, 2017), depression (Leader et al., 2018; McConachie et al., 2018), sexual depression, (Pearlman-Avnion et al., 2017), anxiety (Leader et al., 2018; McConachie et al., 2018), and psychological empowerment

(White, Flanagan, & Nadig, 2018). Also, in a commentary about well-being and QoL in adults with ASD, Kapp (2018) urges that researchers should move away from intra-individual characteristics such as IQ and autism severity, and instead focus on understanding the benefits of autistic symptoms that might be misunderstood as problematic. For instance, the self-regulatory functions of avoiding eye contact, or restricted repetitive behaviors need to be acknowledged.

Several scholars have also suggested that intervention should focus on developing and providing more contexts that provide a high quality social experience as an alternative to intervening on adults with ASD themselves (Kapp, 2018). Increasing social supports (Bishop-Fitzpatrick et al., 2017; Hirvikoski & Blomqvist, 2015; Hong et al., 2016; Renty & Roeyers, 2006) or social participation in recreational activities (Billstedt et al., 2011; Bishop-Fitzpatrick et al., 2017) may be particularly important for this endeavor. Improved support systems should provide more opportunities for individuals with ASD to develop social relationships, and also support families and community members in accepting and appreciating individuals with ASD. However, it is important to highlight the nuances within these contextual variables, as not all types of social support were found to be related to QoL. For instance, perceived availability of informal support (Leader et al., 2018; McConachie et al., 2018; Renty & Roeyers, 2006) and the number of unmet needs (Renty & Roeyers, 2006) were consistently significantly associated with QoL, while received support such as the number of services provided at supported housing (Bennett, Wood, & Hare, 2005) was not related to QoL. This warrants more research on core components of social support that more strongly drive the association with QoL. More primary research on contextual factors that are less often reported in research studies should also be conducted, including access to professional support and family socio-economic status.

4.4. Limitations

When interpreting the results of this meta-analysis, a few limitations should be considered. First, while the age range of participants represented in this study was relatively wide (18–63.6 years), most participants were young adults with ASD. Different findings could emerge in samples that are more representative of older ages. A similar sampling bias occurred for gender, with 62.24% of participants identifying as male. While percent of male participants was not found to moderate effect sizes, it remains possible that studies that include larger or less proportions of female participants could yield different findings. Finally, the analyses reported in this study are correlational and not causal, and do not imply a direction of influence. It could be that greater QoL leads to better social functioning rather than the reverse. As with all correlational studies there are possible 'third variable' explanations that we did not account for that could explain the significant association between social functioning and QoL.

5. Conclusion

To examine the strength of the association between QoL and four putative correlates, this meta-regression analysis synthesized effect sizes from all available published and unpublished studies/datasets on this topic. Results showed insignificant and small correlations between QoL and age, IQ, and autism severity, and significant, positive correlations between QoL and social functioning. Our findings suggest that supporting social functioning in adults with ASD may be a means to increase QoL in this population. However, we also provide additional suggestions for increasing QoL by way of educating neurotypical populations, so that adults with ASD can achieve high QoL regardless of their social functioning. Finally, other factors should be identified to explain variability in QoL in adults with ASD.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.rasd.2018.11.004.

References[1]

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Bennett, H. E., Wood, C. L., & Hare, D. J. (2005). Providing care for adults with autistic spectrum disorders in learning disability services: Needs-based or diagnosis-driven? *Journal of Applied Research in Intellectual Disabilities, 18*, 57–64.

Billstedt, E., Gillberg, I. C., & Gillberg, C. (2011). Aspects of quality of life in adults diagnosed with autism in childhood: A population-based study. *Autism, 15*, 7–20.

Bishop-Fitzpatrick, L., Smith, L. E., Greenberg, J. S., & Mailick, M. R. (2017). Participation in recreational activities moderates the relationship between perceived stress and quality of life in adults with autism spectrum disorder. *Autism Research, 10*(5), 973–982.

*Bishop-Fitzpatrick, L., Mazefsky, C., & Eack, S. M. (2018). The combined impact of social support and perceived stress on quality of life in adults with autism spectrum disorder and without intellectual disability. *Autism, 22*(6), 703–711.

Borenstein, M., Hedges, L. V., Higgins, J. P. T., & Rothstein, H. R. (2009). *Introduction to meta-analysis.* West Sussex, UK: Wiley.

Chiang, H. M., & Wineman, I. (2014). Factors associated with quality of life in individuals with autism spectrum disorders: A review of literature. *Research in Autism Spectrum Disorders, 8*, 974–986.

Cummins, R. (1997). *Comprehensive quality of life questionnaire–intellectual disability.* Deakin University.

*Dijkhuis, R. R., Zierman, T. B., Van Rijn, S. V., Staal, W. G., & Swaad, H. (2017). Self-regulation and quality of life in high-functioning young adults with autism. *Autism, 21*(7), 896–906.

[1] **Article from which effect sizes were extracted. *Articles that did not report an effect sizes of interest but are associated with effect sizes obtained by email correspondence with the first author.

Ehlers, S., & Gillberg, C. (1993). The epidemiology of Asperger syndrome. A total population study. *Journal of Child Psychology and Psychiatry, 34*, 1327–1350.
Esbensen, A. J., Seltzer, M. M., Lam, K. S. L., & Bodfish, J. W. (2009). Age-related differences in restricted repetitive behaviors in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 39*, 57–66.
Frisch, M. B., Cornell, J., Villanueva, M., & Retzlaff, P. J. (1992). Clinical validation of the Quality of Life Inventory. A measure of life satisfaction for use in treatment planning and outcome assessment. *Psychological Assessment, 4*(1), 92–101.
*Gerber, F., Bessero, S., Robbiani, B., Courvoisier, D. S., Baud, M. A., Traoré, M. C., et al. (2011). Comparing residential programmes for adults with autism spectrum disorders and intellectual disability: Outcomes of challenging behavior and quality of life. *Journal of Intellectual Disability Research, 55*, 918–932.
Happé, F., & Charlton, R. A. (2012). Aging in autism spectrum disorders: A mini-review. *Gerontology, 58*, 70–78.
Hedges, L. V., Tipton, E., & Johnson, M. C. (2010). Robust variance estimation in meta-regression with dependent effect size estimates. *Research Synthesis Methods, 1*, 39–65.
*Helles, A., Gillberg, I. C., Gillberg, C., & Billstedt, E. (2017). Asperger syndrome in males over two decades: Quality of life in relation to diagnostic stability and psychiatric comorbidity. *Autism, 21*(4), 458–469.
*Hesselmark, E., Plenty, S., & Bejerot, S. (2014). Group cognitive behavioural therapy and group recreational activity for adults with autism spectrum disorders: A preliminary randomized controlled trial. *Autism, 18*, 672–683.
Hirvikoski, T., & Blomqvist, M. (2015). High self-perceived stress and poor coping in intellectually able adults with autism spectrum disorder. *Autism, 19*, 752–757.
*Hong, J., Bishop-Fitzpatrick, L., Smith, L. E., Greenberg, J. S., & Mailick, M. R. (2016). Factors associated with subjective quality of life of adults with autism spectrum disorder: Self-report versus maternal reports. *Journal of Autism and Developmental Disorders, 46*(4), 1368–1378.
Howlin, P., & Matiagi, I. (2017). Autism spectrum disorder: Outcomes in adulthood. *Current Opinion in Psychiatry, 30*(2), 69–76.
Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. *The Journal of Child Psychology and Psychiatry, 45*(2), 212–229.
Hull, L., Petrides, K. V., Allison, C., Smith, P., Baron-Cohen, S., Lai, M. C., et al. (2017). "Putting on my best normal": Social camouflaging in adults with autism spectrum conditions. *Journal of Autism and Developmental Disorders, 47*(8), 2519–2534.
*Jennes-Coussens, M., Magill-Evans, J., & Koning, C. (2006). The quality of life of young men with Asperger syndrome—A brief report. *Autism, 10*, 403–414.
Jonsson, U., Alaie, I., Löfgren Wilteus, A., Zander, E., Marschik, P. B., Coghill, D., et al. (2017). Annual research review: Quality of life and childhood mental and behavioural disorders—A critical review of the research. *Journal of Child Psychology and Psychiatry, 58*(4), 439–469.
Kapp, S. K. (2018). Social support, well-being, and quality of life among individuals on the autism spectrum. *Pediatrics, 141*(Suppl. 4), S362–S368.
*Kamio, Y., Inada, N., & Koyama, T. (2013). A nationwide survey on quality of life and associated factors of adults with high-functioning autism spectrum disorders. *Autism, 17*, 15–26.
*Kamp-Becker, I., Schroder, J., Remschmidt, H., & Bachmann, C. J. (2010). Health- related quality of life in adolescents and young adults with high functioning autism-spectrum disorder. *Psycho-Social Medicine, 7*, Doc3.
Kern, J. K., Trivedi, M. H., Garver, C. R., Grannemann, B. D., Andrews, A. A., Salva, J. S., et al. (2006). The pattern of sensory processing abnormalities in autism. *Autism, 10*, 480–494.
**Khanna, R., Jariwala-Parikh, K., West-Strum, D., & Mahabaleshwarkar, R. (2014). Health-related quality of life and its determinants among adults with autism. *Research in Autism Spectrum Disorders, 8*, 157–167.
Lai, M. C., Lombardo, M. V., Ruigrok, A. N., Chakrabarti, B., Auyeung, B., Szatmari, P., et al. (2017). Quantifying and exploring camouflaging in men and women with autism. *Autism, 21*(6), 690–702.
**Leader, G., Grennan, S., Chen, J. L., & Mannion, A. (2018). An investigation of gelotophobia in individuals with a diagnosis of high-functioning autism spectrum disorder. *Journal of Autism and Developmental Disorders, 48*(12), 4155–4166.
*Lin, L. Y. (2014). Quality of life of Taiwanese adults with autism spectrum disorder. *PLoS One, 9*, e109567.
Lord, C., Risi, S., Lambrecht, L., Cook, E. H., Leventhal, B. L., DiLavore, P. C., Pickles, A., & Rutter, M. (2000). The autism diagnostic observation schedule-generic: a standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders, 30*(3), 205–223.
Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism Diagnostic Interview-Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24*(5), 659–685.
Marriage, S., Wolverton, A., & Marriage, K. (2009). Autism spectrum disorder grown up: A chart review of adult functioning. *Journal of the Canadian Academy of Child and Adolescent Psychiatry, 18*, 322–327.
*Mason, D., McConachie, H., Garland, D., Petrou, A., Rodgers, J., & Parr, J. R. (2018). Predictors of quality of life for autistic adults. *Autism Research, 11*(8), 1138–1147.
*McConachie, H., Mason, D., Parr, J. R., Garland, D., Wilson, C., & Rodgers, J. (2018). Enhancing the validity of a quality of life measure for autistic people. *Journal of Autism and Developmental Disorders, 48*(5), 1596–1611.
Mitchell, P. (2015). Mindreading as a transactional process: Insights from autism. In V. Slaughter, & M. de Rosnay (Eds.). *Theory of mind development in context* (pp. 135–150). New York: Psychology Press.
**Moss, P., Mandy, W., & Howlin, P. (2017). Child and adult factors related to quality of life in adults with autism. *Journal of Autism and Developmental Disorders, 47*(6), 1830–1837.
Noens, I., De la Marche, W., & Scholte, E. (2012). *SRS-A Screeningslijst voor autismespectrum stoornissen bij volwassenen.* Amsterdam: Hogrefe Uitgevers.
Pearlman-Avnion, S., Cohen, N., & Eldan, A. (2017). Sexual well-being and quality of life among high-functioning adults with autism. *Sexuality and Disability, 35*, 279–293.
Renty, J. O., & Roeyers, H. (2006). Quality of life in high-functioning adults with autism spectrum disorder: The predictive value of disability and support characteristics. *Autism, 19*(5), 511–524.
Rutter, M., Bailey, A., Lord, C., & Berument, S. K. (2003). *Social Communication Questionnaire.* Angeles, CA: Western Psychological Services.
*Saldaña, D., Álvarez, R. M., Lobatón, S., Lopez, A. M., Moreno, M., & Roiano, M. (2009). Objective and subjective quality of life in adults with autism spectrum disorders in southern Spain. *Autism, 13*, 303–316.
Sasson, N. J., & Morrison, K. E. (2017). First impressions of adults with autism improve with diagnostic disclosure and increased autism knowledge of peers. *Autism* (online).
Schalock, R. L. (2004). The concept of quality of life: What we know and do not know. *Journal of Intellectual Disability Research, 48*(3), 203–216.
Schalock, R. L., & Keith, K. D. (1993). *Quality of life questionnaire.* Worthington, OH: IDS Publishers.
Seltzer, M. M., Krauss, M. W., Shattuck, P. T., Orsmond, G., Swe, A., & Lord, C. (2003). The symptoms of autism spectrum disorders in adolescence and adulthood. *Journal of Autism and Developmental Disorders, 33*, 565–581.
Shattuck, P. T., Seltzer, M. M., Greenberg, J. S., Orsmond, G., Bolt, D., Kring, S., et al. (2007). Change in autism symptoms and maladaptive behaviors in adolescents and adults with an autism spectrum disorder. *Journal of Autism and Developmental Disorders, 37*, 1735–1747.
Schopler, E., Reichler, R., & Rochen Renner, B. (1988). *The childhood autism rating scale.* Western Psychological Services.
StataCorp (2017). *Stata statistical software: Release 15.* College Station, TX: StataCorp, LLC.
Strain, P. S. (2001). Empirically based social skill intervention: A case for quality-of-life improvement. *Behavioral Disorders, 27*(1), 30–36.
Tobin, M. C., Drager, K. D. R., & Richardson, L. F. (2014). A systematic review of social participation for adults with autism spectrum disorders: Support, social functioning, and quality of life? *Research in Autism Spectrum Disorders, 8*(3), 214–229.
Tremblay, G., & Martin-Laval, H. (1997). *Inventaire de qualité de vie en milieu résidentiel, I.Q.V.M.R.* Montréal, Québec: Les Editions de la collectivité.
Trompenaars, F. J., Masthoff, E. D., Van Heck, G. L., De Vries, J., & Hodiamont, P. O. (2007). Relationships between social functioning and quality of life in a population of Dutch adult psychiatric outpatients. *International Journal of Social Psychiatry, 53*(1), 36–47.
Van der Zee, K. I., & Sanderman, R. (1993). *Het meten van de gezondheidstoestand met de RAND-36: Een handleiding.* Groningen: Noordelijk Centrum voor gezondheidsvraagstukken.
van Gameren-Oosterom, H. B. M., Fekkes, M., Buitendijk, S. E., Mohangoo, A. D., Bruil, J., & Van Wouwe, J. P. (2011). Development, problem behavior, and quality of

life in a population based sample of eight-year-old children with Down syndrome. *PLoS One, 6*(7), e21879.
*Van Heijst, B. F. C., & Geurts, H. M. (2015). Quality of life in autism across the lifespan: A meta-analysis. *Autism, 19*, 158–167.
*White, K., Flanagan, F., & Nadig, A. (2018). Examining the relationship between self-determination and quality of life in young adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 30*(6), 735–754.
World Health Organization, & Division of Mental Health and Prevention of Substance Abuse (1997). *WHOQOL : Measuring quality of life*. Geneva: World Health Organization.
Zimmerman, D., Ownsworth, T., O'Donovan, A., Roberts, J., & Gullo, M. J. (2018). High-functioning autism spectrum disorder in adulthood: A systematic review of factors related to psychosocial outcomes. *Journal of Intellectual and Developmental Disability, 43*, 219.

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