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Prevalence and Risk Factors Associated with Malnutrition among Children with Learning Disabilities: A Scoping Review

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ABSTRACT

Introduction: By the end of 2015, about 72,152 children with learning disabilities were registered under the Malaysian Welfare Service Department (JKM). Malnutrition has been found to be a common setback among children with learning disability (LD). This study presents available evidence on the prevalence and risk factors associated with malnutrition in children with LD. **Methods:** A framework suggested by Arksey & O`Male (2005) was used to carry out this scoping review. Published articles, reviews and reports were identified through a complete search. Inclusion criteria for the search were English articles related to LD, published from 2005 to 2016. **Results:** Seventeen international studies published from 2005 until 2015 with a total of 318,596 participants and one study involving 281 participants from Malaysia, were identified and included in this review (n=18). The target age range of the sample in these 18 studies was 2 - 20 years, with a mean age of 3.2 - 14.2 years. The prevalence of underweight among children with LD was 3.4 - 36%, overweight 7.6 - 37% and obesity 5.7 - 52%. Several studies reveal that malnutrition risk among children with LD is significantly associated with gender, age, genetic syndrome, type of disability, medication used, and country economic status. **Conclusion:** A number of studies show that children with LD have a higher prevalence of being overweight and obese than typically developing children and the risk associated with obesity significantly increases with age.

Key words: Children, learning disabilities, malnutrition, prevalence, risk factors

INTRODUCTION

According to the US National Library of Medicine (2016), learning disability is defined as conditions characterised by a significant discrepancy between an individual's perceived level of intellect and his/her ability to acquire new language and other cognitive skills. These disorders may result from organic or psychological conditions. Relatively common subtypes include dyslexia, dyscalculia, and dysgraphia. A person is said to have learning disability (LD) when he/she suffers from a disorder that may affect acquisition, organisation, retention, understanding or use of verbal or non verbal information. Individuals with these disorders experience difficulties in learning

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and exhibit average abilities essential for thinking and/or reasoning. Impairments in one or more processes related to perceiving, thinking, remembering or learning lead to LD. These include, but are not limited to language processing, phonological processing, visual spatial processing, processing speed, memory and attention, and executive functions (e.g. planning and decision-making) (Walcot-Gayda, 2010). LD could also be a symptom or a syndrome, for example, developmental disorders such as Down Syndrome, Autism Spectrum Disorder, and Cerebral Palsy with one of the characteristics of the syndrome being LD.

In Malaysia, 'Intellectual Disabilities' is identified by the Ministry of Education as 'Learning Difficulties' (MOE, 2013). In fact, the Centres for Disease Control and Prevention (CDC) have subdivided children into three groups: infants (ages 0-3), children (ages 4-11), and teens (ages 12-19) (CDC, 2015). However, for purposes of this review, all in the age range of 0-18 years have been considered as children. Children with LD include those who are diagnosed with Down Syndrome, Mild Autism, Attention Deficit Hyperactive Disorder, Mild Retardation, and Specific Learning Disabilities (e.g. Dyslexia). Based on data obtained from the Malaysian Department of Social Welfare, the total number of children registered with LD as at the end of 2015 was 75, 152. The number of new LD registrations in 2011 for children aged 7-12 years was 5,700, while the number of new registrations in 2012 was 8,856 (NECIC, 2013). The number of registrations experienced a hike of 55% within a year. This clearly shows that LD awareness among parents and society in general has improved over the year.

Malnutrition had been identified as a common setback among children with LD. According to UNICEF, malnutrition is a broad term that is used to cover both under-nutrition and over-nutrition. The malnutrition framework by UNICEF (2013) has been used to identify the potential risk factors for under-nutrition. However, to our knowledge, no framework is available for over-nutrition. According to Holcomb, Pufpaff & McIntosh (2009), children with intellectual/learning disability typically experience trouble in leading a healthy lifestyle due to their cognitive, sensory, and physical limitations. For instance, these children are unable to feed themselves and require help from others. Thus, under-nutrition can be readily caused by inadequate nutrition provision to these children, resulting in limited preferences in food consumption (Wong, 2011). In the worst case scenario, the poor nutrition status of these children may lead to weight loss, as well as malnourishment due to multiple medical conditions and societal participation issues. For overweight and obese children with LD, increased attention and immediate intervention is required as numerous associated secondary medical problems caused by excess body weight can adversely affect their functional status. Furthermore, children with LD are more likely to engage in sedentary activities, such as watching television, playing computer games or sleeping as their disabilities limits them from participating in sports or recreational games that require a higher level of physical fitness, cognition, and more refined motor skills (Kasser & Lytle, 2005).

Thus, this review of published articles aimed to collate and chart data and summarise the current available evidence pertaining to the prevalence and risk factors associated with overweight and obesity among children with LD.

METHODS

The present study was designed as a scoping review with the aim of describing the prevalence of malnutrition, as well as identifying the risk factor associated with malnutrition. Our review was based on the 5-stage scoping review framework of

Arskey & O'Malley (2005) which follows this order: 'identifying the research questions', 'identifying relevant studies', 'study selection', 'charting the data' and 'collating, summarising and reporting the results'.

Identifying the research questions

The review questions were: (1) what is the prevalence of malnourished children with LD aged 18 years and below? (2)What are the risk factors associated with malnutrition among LD children worldwide?

Identifying relevant studies

An electronic search was first conducted on the following databases: Science Direct, PubMed, Medscape and Google Scholar, as well as relevant research websites such as World Health Organizations (WHO), Centres for Disease Control and Prevention (CDC) and Malaysian Department of Social Welfare. This search was limited to articles published in the English language or in peer-reviewed journal articles and review articles, published between 2005 and 2016. Titles, abstracts, keywords for eligibility were examined independently by the researchers. All studies including systematic reviews and other categories of review papers were included in the search. Key terms used in the search for articles are found in Table 1.

Study selection

The studies that were identified and included in this review provided information on (i) characteristics of the participants (i.e. gender, age, and type of disability); (ii) procedures and methods used for height and weight data collection; (iii) identification or definition of overweight and obesity (i.e. formula and classification criteria used); (iv) data on prevalence of underweight, overweight or obesity; and (v) risk factors or factors associated with nutritional status of the participants.

Charting the data

The author(s), year of publication, aims of the study, sample characteristics, size and design, instruments used in the study and also findings that were relevant to the review were summarised in a table according to the countries where the research was done.

Collating, summarising and reporting the results

The findings of the review are presented in tables of evidence on the prevalence of malnutrition of children with LD as well as the risk factors associated with malnutrition.

Table 1. Key terms in the scoping review

Prevalence AND risk factors AND malnutrition AND children AND learning disabilities OR Autism spectrum disorder	Occurrence AND risk factors AND overweight OR underweight AND children AND learning disabilities OR autism spectrum disorder
Prevalence AND risk factors AND malnutrition AND children AND learning disabilities OR Down syndrome	Occurrence AND risk factors AND overweight OR underweight AND children AND learning disabilities OR down syndrome
Prevalence AND risk factors AND malnutrition AND children AND learning disabilities OR Attention deficit hyperactivity disorder	Occurrence AND risk factors AND overweight OR underweight AND children AND learning disabilities OR attention deficit hyperactivity disorder

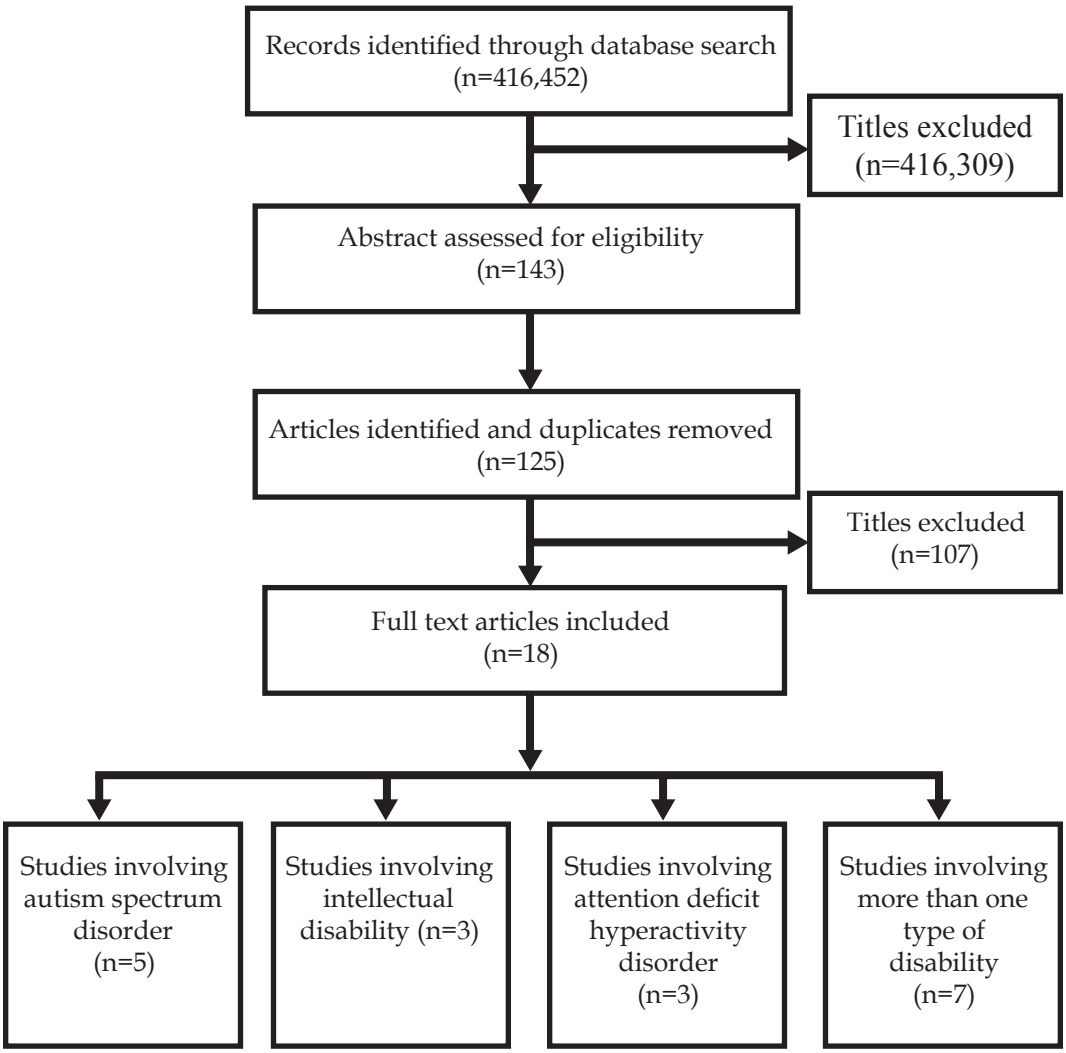

Figure 1. Flow chart of scoping review (based on framework by Arksey & O`Malley, 2005)

RESULTS

This search strategy allowed for the identification of a total of 416,452 titles. Seventeen international and one local published study on children with LD were included after the final screening process. The rest were excluded due to their irrelevant content or because they duplicated the selected studies. The international studies included in this review employed samples that combined both children and adolescents or those that exclusively comprised children living in nine countries and included those attending special schools (i.e. Australia, China, France, Korea, Taiwan, Turkey, Iran, and the United States of America).

Prevalence and risk factors of malnutrition among children with LD

A breakdown of these 18 studies revealed that 7 examined the prevalence of

underweight among children with LD, 12 examined the prevalence of overweight, and 13 examined the prevalence of obesity. However, Gottlieb *et al.* (2009) did not clearly state the type of learning disability covered in their study. These 18 studies included samples that combined children and adolescents (n = 18). The findings revealed that the overall prevalence of underweight ranged from 3.4% to a median of 36%. Meanwhile, the prevalence of overweight ranged from 9.4% to 37%, and the prevalence of obesity in children ranged from 5.7% to 52% (Gottlieb *et al.,* 2009; Lin *et al.,* 2005; De, Small & Baur, 2008; Li *et al.,* 2008; Rimmer *et al.,* 2010; Xia *et al.,* 2010; Güngör, Celilog, & Raif, 2016; Choi *et al.,* 2012; Chen *et al.,* 2013; Bégarie *et al.,* 2013; Lloyd, Holey & Temple, 2014; Broder-Fingert *et al.,* 2014; Zuckerman *et al.,* 2014; Presmanes, Zukerman & Fombonne, 2015; Bandini *et al.,* 2015).

The prevalence and potential risk factors associated with overweight and obesity in LD children were examined by 14 of the reviewed studies as shown in Table 2. These studies focused on demographics (i.e. gender and age), clinical (i.e. LD level, genetic syndromes, medication use, type of disability, characteristics of disorder, eating habits/dietary behaviour, and physical activity), and social factors (e.g. household income).

Risk factors associated with malnutrition

Gender

The association between gender and malnutrition among children with LD was examined in five studies (Choi *et al.,* 2012; Bégarie *et al.,* 2013; Broder-Fingert *et al.,* 2014; Zuckerman *et al.,* 2014; Lloyd *et al.,* 2014). Indeed, one study found a significant association between gender and overweight, suggesting a higher level of overweight in girls compared to boys by 1.5 times (Bégarie *et al.,* 2013). Two studies (Broder-Fingert *et al.,* 2014; Choi *et al.,* 2012) found a significant association between gender and overweight but the results contradicted each other another. Another study that compared sex related differences in BMI status within economic levels found a higher number of underweight males in higher in low income countries. Conversely, it found a higher prevalence of obese females in high income countries (Lloyd *et al.,* 2014).

Age

The relationship between the prevalence of overweight and obesity with age was examined in six of the reviewed studies (Lin *et al.,* 2005; Choi *et al.,* 2012; Broder-Fingert *et al.,* 2014; Bégarie *et al.,* 2013; Zuckerman *et al.,* 2014; Presmanes *et al.,* 2015). With regard to the prevalence of overweight and obesity across ages, Bégarie *et al.* (2013) found a significant relationship between age and obesity among children. The results indicated that a 1-year increase in age increased the odds of being obese by 9.6%. Similar results were reported by Choi *et al.* (2012) and Broder-Fingert *et al.* (2014) where older children had a higher prevalence of obesity. Conversely, Presmanes *et al.* (2015) found the prevalence of obesity to be higher in younger children. However, the results of Lin *et al.* (2005) and Zuckerman *et al.* (2014) showed an insignificant relationship.

Severity of Learning Disabilities (LD)

The association between the severity of LD and overweight was examined by three of the reviewed studies (Lin *et al.,* 2005; De *et al.,* 2008; Bégarie *et al.,* 2013). The results from the studies failed to demonstrate any significant association between the severity of LD and overweight or obesity in children.

Genetic syndromes

The association between genetic syndromes commonly associated with LD and overweight/obesity was examined in six of the reviewed studies (De *et al.,*

Table 2. Prevalence and risk factors associated with malnutrition of children with LD

Country	*Study*	*Purpose of the study*	*Participants' Characteristics*	*Classification Criteria*	*Prevalence*	*Risk factors*
Taiwan	*Lin et al.* (2005)	• Analyse patterns of obesity among children and adolescents with ID • Compare data with existing national norms to identify the scale of obesity problem.	Children and adolescents with intellectual disabilities; n=279; age range: 4-18 years old; Boys: 63.1% Girls: 36.9%	BMI: According to Third Taiwanese National Nutrition and Health Survey (1993-1996)	Obese: 52%	No findings
USA	Johnson *et al.* (2008)	• To examine the eating habits and nutritional intake of ASD and compare with normal children	Children with Autism and typically developing children; n=34 (19 autism, 15 control); age range: (3-3.3 years old)	Feeding Assessment Survey (FAS)	No findings	Mean score of FAS for autism child was higher than control (11.39 and 5.47)
USA (2008)	Li *et al.*	• Examined the associations between academic performance (AP), cognitive functioning (CF) and increased BMI in a nationally representative sample of children.	Children; n=2519; age range: 8-16 years old; mean age: 12 years old; Boys: 51.98% Girls: 48.02%	BMI: According to CDC 2000 Growth Chart	Overweight: 15.9%	Decrease cognitive functioning was associated with increase in weight.
Australia	De *et al.* (2008)	• To determine the prevalence of overweight and obesity in children with developmental disabilities attending a metropolitan Diagnosis and Assessment Service.	Children diagnosed with intellectual disability or global development delay; n=98; age range: 2-18 years old; Boys: 68.4% Girls: 31.6%	BMI: According to CDC 2000 Growth Chart	Overweight: 24% Obese: 15%	ID level: Mild 47%; moderate 38%; Severe 15%

Asian and African countries	Gottlieb *et al.* (2009)	• Estimate the percentage of children screened positive with disability or at risk of disability • Assess the association between disability screening result and nutritional variables, exposure to early learning activities and school attendance.	Children; n=191,199; age range: 2-9 years old	NCHS/WHO criteria	Underweight: 36%	Median of 23% screened positive for disability. Median of 26% for stunting.
USA	Rimmer *et al.* (2010)	• To explore the prevalence of obesity and related secondary conditions associated with obesity in adolescent with ID/IDD	Children with intellectual/ learning disability; n=461; age range: 12-18 years old; mean age: 14.9 years old; boys: 67.5% girls: 32.5%	BMI: According to CDC 2000 Growth Chart	Overweight: 37% Obese: 18.1%	Autism and Down Syndrome patients were more likely to be obese.
China	Xia *et al.* (2010)	• Evaluate the nutritional status and the nutrient intake of autism children	Autistic children; n=111; age range: 2-9 years old; mean age: 4.9 years old; boys: 89.2% girls: 10.8%	Evaluated by the Z score method using standards of the NCHS for WHO	Underweight: 8.1% Overweight: 31.5%	Majority of children had inadequate intake of folic acid, calcium, and vitamin B6.
Iran	Azadbakht *et al.* (2012)	• Assess the relation of major dietary patterns to ADHD	Children; n=375; age range: 7-9 years old; mean age: 8 years old; boys: 52% girls: 48%	Obesity classification: According to International Obesity Task Force for children	Mean of obese: 10	Significant association between sweet and fast food dietary pattern with ADHD
Korea	Choi *et al.* (2012)	• Examine the prevalence of overweight and obesity in Korean children without specific genetic syndrome or physical disabilities	Children with ID; n= 2404; age range: 7-18 years old; boys: 70.6% girls: 29.4%	BMI: Korea Center for Disease Control and Prevention	Underweight: 12.2% Normal: 61.6% Overweight: 12.2% Obese: 11.9%	No findings

Country	*Study*	*Purpose of the study*	*Participants' Characteristics*	*Classification Criteria*	*Prevalence*	*Risk factors*
Korea	Park *et al.* (2012)	• Investigate the association between a wide range of measures of dietary behavior and LD and ADHD in order to generate hypothesis for future work	Children; n=986; age range: 8-11 years old; mean age: 9.1 years old; boys: 51.4% girls: 48.6%	Child's dietary behavior: using Mini Dietary Assessment (MDA) for Koreans	Not findings	High intake of sweetened desserts, fried food, and salt associated with more behavioral problems.
Turkey	Güngör *et al.* (2013)	• Present nutritional status of children and adolescent with ADHD and to investigate relationship between ADHD and obesity	Children diagnosed with ADHD and normal children; n=752 (ADHD 362, control 390); boys: (ADHD 85.6%, control 80.8%) Girls: (ADHD 14.4%, control 19.2%)	BMI: National percentile curve	Underweight: 16.8% Overweight: 9.4% Obese: 7.1%	Malnutrition in ADHD was associated with excessive mobility and might be due to behavioural problem.
Malaysia	Chen *et al.* (2013)	• Assess the nutritional status of person with disability and identify the malnutrition risk factors	People with disabilities; n=462 (276 children and adolescent, 186 adults)	BMI: according to WHO 2000	Underweight: 17.8% Overweight: 7.6% Obese: 7.6%	Self-feeding ability, eating duration, drooling, and dental problem had associations with BMI of children.
France	Bégarie *et al.* (2013)	• Examine the prevalence of overweight and obese among people with ID • Identify potential association between overweight, obese and their potential determinants	Children and adult with intellectual disability; n=1120; age range: 5-28 years; mean age: 15.98 years old; boys: 61.2% girls: 38.8%	BMI cuts off based on International Obesity Task Force	Overweight: 14.8% Obese: 5.7%	ID level: Mild 38.4%; moderate 40%; severe 15.2%

		• Investigate the moderating effects of gender and age on the association between overweight, obese and potential determinants				
USA	Broder-Fingert *et al.* (2014)	• Compare the prevalence of overweight and obesity between ASD or Asperger syndrome and normal children • Investigate potential factors associated with overweight and obese, including age, gender, race, medications use and co-occuring condition.	Children; n= 2976; age range: 2-20 years old; boys: (ASD or AS 79.3%, control 50.1%); girls: (ASD or AS 20.7%, control 49.9%)	BMI: CDC 2000 Growth Chart	Overweight: (ASD 14.8%, AS 11.1%) Obese: (ASD 23.2%, AS 25.3%) Normal children: Overweight: 10.9% Obese: 6.3%	High prevalence of overweight among public insurance holder, significant association between obesity with sleep disorders, no significant association between medications intake with obese and overweight.
141 countries	Lloyd *et al.* (2014)	• Report on BMI status of children and youth special Olympians by country world economic status	Children and youth who participated in Special Olympics; n=14032; age range: 8-17 years old; average age: 13.5 years old; boys: 63.1% girls: 36.9%	BMI cuts off based on International Obesity Task Force	Underweight: 3.4% Overweight: 19.2% Obese: 9.5%	Weight status was associated with country economic status.

Country	*Study*	*Purpose of the study*	*Participants' Characteristics*	*Classification Criteria*	*Prevalence*	*Risk factors*
USA and Canada	Zuckerman *et al.* (2014)	• Evaluate the prevalence of overweight and obese ASD. • Determine whether socio-demography characteristics, ASD symptoms, cognitive and adaptive functioning, behavioral problem and treatment is associated with obese or overweight.	Children with ASD; n= 376; age range: 2-18 years old; mean age: 5.5 years; boys: 82.7%, girls: 17.3%	BMI: According to CDC 2000 Growth Chart ASD diagnosis: DSM-IV-TR	Overweight: 18.1% Obese: 17.0%	No significant association between socio-demography characteristics and autism severity with obese and overweight. Sleep disturbance significantly associated with obesity. BMI and psychotropic medication are not significantly associated. Melatonin use has weak association with obesity.
USA	Bandini *et al.* (2015)	• Summarizes current knowledge about prevalence of obesity among development/physical disabilities • Discuss factors influencing obesity risk and summarizes recommendations for research presented at the conference	Data sources and sample: •NHANES (2005-2012): Children, 5-17 years old, n=1200 •NHIS (2008-2013): children, 12-17 years old •NSCH (2011): Children and adolescent, 0-17 years old, n= 95,000	BMI: CDC 2000 Growth Chart	Obese: 26.7%	Disabled children were more likely to be obese than control. The number of obese children with intellectual/ learning disability was

						higher than the others.
America	Presmanes *et al.* (2015)	• To examine prevalence of unhealthy weight of ASD compared with NHANES sample. • Examine family- and child-level factors associated with unhealthy weight among children with ASD. • Examine hypothesis regarding association between unhealthy weight and factors unique to children with ASD.	Children with ASD; n=5053; age range: 2-17 years old; boys: 84.5% girls: 15.5%	BMI: CDC 2000 Growth Chart	ASD children: Underweight: 4.7% Normal: 61.7% Overweight: 15.6% Obese: 18.0% NHANES sample: Overweight: 31.8% Obese: 16.7%	No association between BMI and dietary interventions, melatonin use, stimulants and non-stimulants ADHD medicine and anticonvulsant. Total psychotropic medication prescribed significantly associated with BMI category.

BMI: weight in kg/height metre squares
NHANES: National Health and Nutrition Examination Survey
NHIS: National Health Interview Survey
NSCH: National Survey of Children's Health
NCHS: National Centre for Health Statistics
CDC: Centres for Disease Control and Prevention
LD: Learning disability
DD: Developmental disability
ASD: Autism spectrum disorder
ADHD: Attention deficit hyperactivity disorder
AS: Asperger syndrome
DS: Down syndrome
ID: Intellectual disability

2008; Choi *et al.,* 2012; Bégarie *et al.,* 2013; Broder-Fingert *et al.,* 2014; Presmanes *et al.,* 2015; Bandini *et al*., 2015). These studies found a a significant association between overweight/obesity and genetic syndromes (i.e. autism, attention deficit hyperactive disorder, developmental delay, additional medical conditions with an organic basis, or Down syndrome) among youths with LD. Their findings showed that the prevalence of overweight/obesity was higher among children with LD or nearly twice that of normal children. However, only one study (Güngör *et al*.,2013) found a significant association between wasting and ADHD. Wasting in this case could be due to behavioral problems and excessive mobility which consequently increases energy requirements.

Medication use

The relationship between the use of psychotropic medication and overweight or obesity among children with LD was examined in four studies (Bégarie *et al.,* 2013; Broder-Fingert *et al*., 2014; Zuckerman *et al*., 2014 & Presmanes *et al.,* 2015). Psychotropic medications such as anti-depressants, anti-psychotic or anti-epileptics are usually prescribed to those who experience severe or uncontrolled behavioral problems. Bégarie *et al.* (2013) found that gender significantly moderated the relationship between psychotropic medication and being overweight. However, the study did not provide information on the type as well as frequency of the medication used. Meanwhile, Presmanes *et al*. (2015) found a significant association between prescribed psychotropic medicines and BMI category of their participants. Conversely, another two studies gave contradictory results.

Type of disability

Three of the reviewed studies (Rimmer *et al.,* 2010; Bégarie *et al.,* 2013; Bandini *et al.,* 2015) found a significant relationship between overweight/obesity and the type of disability. Bandini *et al.* (2015), in fact, showed that children with LD/ID had higher rates of obesity, while the other two studies (Rimmer *et al.,* 2010; Bégarie *et al.,* 2013) showed that children with Down Syndrome were more likely to be obese than those with other disabilities.

Eating habits/dietary pattern

The eating habits/dietary pattern of children with LD was observed in four reviewed studies (Johnson *et al*., 2008; Xia *et al.,* 2010; Azadbakht & Esmaillzadeh, 2012; Park *et al.,* 2012). However, no study displayed a clear relationship between eating habits/dietary pattern and malnutrition risk among children with LD. Nonetheless, one study examined obesity rate with dietary pattern and based on the results obtained, obesity was associated with a dietary pattern of sweet and fast food. In addition, the other two studies (Azadbakht & Esmaillzadeh, 2012; Park *et al.,* 2012) provided results indicating a significant relationship between sweet food intake and ADHD.

Physical activity

Only one study had looked into the relationship between physical activity and overweight/obese and the result showed an insignificant association (Bégarie *et al.,* 2013). However, no information on the type of physical activity or the intensity of the exercise was mentioned in the study.

Socio-economic status

The relationship between obesity and indicators of socio-economic status was tested in only one study (Lloyd *et al.,* 2014). Their results showed that underweight had the highest rates in low income countries, whereas overweight and obesity rates were highest in high income countries.

DISCUSSION

Compared to healthy and normal individuals, very limited studies have

assessed the nutritional status of people with disabilities. Learning disability, also referred to as intellectual disability in certain countries, is a disability that requires additional help and greater attention from the people around them. People with LD are often prone to a poor nutritional status due to their special characteristics. In fact, in Malaysia, only one study had assessed the nutritional status of children with LD. However, developed countries, such as the United States and Canada, have given more attention to this group over the last few decades; here several studies and intervention programs have been carried out for LD individuals, but even they have not been able to cater to all their special needs.

The first objective of this article was to review the prevalence of malnutrition, with a focus on the rates of underweight, overweight, and obesity in children with LD. The results obtained were not unexpected and were similar to other published review articles, but what was surprising was the classification criteria used in each study to categorise participants into each BMI category (Maïano, 2010). Among the 18 studies, only 15 provided data on BMI of the participants. Of these studies, seven used data from the Centres for Disease Control and Prevention (CDC) (2000), three used data from the International Obesity Task-Force (IOTF), three used World Health Organization (WHO) (2000) data, one study used data from the Korean Centers for Disease Control and Prevention while one study failed to clearly state the guideline used for the classification of BMI. It was not surprising therefore that the results varied according to the classification of BMI. The prevalence of underweight using WHO criteria ranged from 8.1 - 36%, while for the study that relied on IOTF criteria, the prevalence rate was 3.4%. However, the prevalence of overweight in studies using CDC (2000) for its BMI classification had rates that were higher than WHO and IOTF, that is, 12.2% and 37.0%. In the case of obesity too, studies that relied on CDC 2000 found a higher prevalence of 15.0% - 48.5% compared to IOTF and WHO.

The variation found on the prevalence of malnutrition in reviewed studies might be due to several limitations of the study itself. One possible reason is that most of the studies are cross-sectional and the selected participants in the study are not demographically reflective of the overall population with learning disabilities (Broder-Fingert *et al.,* 2014). Moreover, as a few studies relied on secondary data (Zuckerman *et al.,* 2014), missing data was a major limitation as the researchers could not further investigate the causes of malnutrition. Obesity can be both a reason and outcome of various additional problems, therefore interpretation made based on the association found should be discussed thoroughly (Zuckerman *et al.,* 2014) and other co-factors should be taken into account. Some of the reviewed studies included children with Down syndrome which were likely to explain the differences in the prevalence of malnutrition due to the characteristics of the syndrome itself. Other reasons might due to differences in study design, sample size, recruitment procedure and methods used in assessing nutritional status. (Noor Safiza *et al*., 2015)

The second objective of this article was to identify the risk factors related to malnutrition among children with LD. The risk factors included gender, age, severity of LD, types of disabilities, genetic syndrome, medication used, geographic location, socio-economic status, physical activity, and dietary pattern/behaviour. As a result, almost all risk factors listed showcased a significant association with malnutrition, but some risk factors failed to display any clear relationship; these areas clearly need further research to provide clarification. Conversely, physical activity was the only factor that showed

no association with malnutrition status among children with LD. Even then, a study conducted by Salaun & Berthouze-aranda (2012) revealed a high prevalence of obesity among adolescents with intellectual disabilities and the physical test demonstrated that they had low physical fitness, thus providing an explanation for the association between physical activity and obesity.

Both gender and age had a significant association with overweight and obesity. Gender differences in body fat composition are distinct during adolescents and adults (Lovejoy *et al.*, 2009) whereas the differences are small during the childhood period (Wells, 2006). During adolescents, females reach puberty earlier than males resulting in a much higher body fat composition. Thus the significant association between gender and age with overweight/obesity could be explained by the broad age group the sample falls into (Choi *et al.*, 2012).

In addition, some reviewed articles offered data on the dietary intake and pattern of LD among children. The study of Johnson *et al* (2008) revealed that although the intake of total calorie and macronutrients (carbohydrate, protein, and fat) in autistic children was not significant, they consumed less vegetables and vitamin K. Meanwhile, another study showed that the majority of autistic children had inadequate intake of folic acid, calcium, and vitamin B6 (Xia *et al.*, 2010). This might be due to the small intake of animal source food, as well as less consumption of vegetables.. On the other hand, two studies that focused on the association between dietary patterns and behavioural problems among ADHD children found that sweetened, high fat, and salty food was significantly associated with ADHD and obesity (Azadbakht & Esmaillzadeh, 2012). However, no clear explanation was provided pertaining to the mechanisms of this association in those articles.

Only one study provided data on the association between characteristics of disabilities in children and BMI status. It further showed that malnutrition could be a result of self-feeding abilities, eating duration, drooling, and dental problems which have significant effects on the BMI of disabled children. These characteristics could affect the intake of a balanced diet due to limited food preferences and lack of help from others during mealtime, thus resulting in malnutrition (Chen *et al.*, 2013)

One study that assessed obesity-related health conditions among adolescents with LD showed that secondary health conditions such as high blood cholesterol and diabetes mellitus were higher in obese adolescents with LD compared to those with normal weight (Rimmer *et al.*, 2007). Nevertheless, future research has to address this issue and proper interventions involving this group are necessary to combat issues related to overweight and obesity. This is an imperative if we are to avoid later health complications in adulthood, besides minimising living and health costs.

CONCLUSION

In conclusion, despite the numerous intervention programs organised to combat malnutrition at a global level, malnutrition does not show a reducing trend. In fact, the prevalence of malnutrition has been increasing gradually. Therefore, more effective strategies with new interventions programs are needed to prevent malnutrition from becoming a worldwide problem particularly among children with LD as they face the risk of being left behind. Furthermore, the reviewed articles indicate an unconvincing association between physical activity and malnutrition and this requires further research to check the veracity of this association The findings of this study can provide a baseline for future studies to identify the multiple risk factors associated with malnutrition among this vulnerable population.

Conflict of interest

The authors have no conflict of interest.

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