**Abstract**

*Background:* People with intellectual and developmental disabilities (IDD) are at risk of developing long term health conditions, and a preventative health agenda research is emerging. However, little is known about the recruitment settings, delivery contexts, intervention techniques and outcomes of health promotion programmes for this population. Therefore, the aim of this review was to synthesize and evaluate these characteristics.

*Method:* A systematic review of studies identified from multiple databases on healthy lifestyle interventions for adolescents and young people with IDD was conducted. Data were synthesized and evaluated using a logic model. Quality of rigour was also assessed.

*Results:* Sixteengeographically diverse studies were selected and evaluated. Participants were most commonly recruited from schools, with interventions typically taking place in a gym setting and involving physical activity training.

*Conclusions:* This review indicates that physical activity and dietary interventions in people with IDD may lead to lifestyle changes, however more robust evidence is required. Educational settings are conducive, with settings beyond schools requiring further consideration.

**What this paper adds**

The review provides a comprehensive overview of the study settings, delivery contexts, intervention techniques and outcomes in health research targeting adolescents and young people with IDD. This has implications for how future studies in this area are conducted, as research with a preventative agenda has hitherto recruited primarily from school settings. The recruitment advantages of these settings are highlighted, such as approaching large participant groups and support from educational professionals. However, it is demonstrated that additional settings, such as further education institutions, would potentially provide similar advantages yet reach wider and more independent samples in terms of capacity to make autonomous lifestyle choices.

Evidence to date has demonstrated the efficacy of physical activity interventions on lifestyle change in people with IDD. However, whilst many of the intervention techniques necessitated specialist equipment and subsequently gym settings, there were also simpler, effective techniques, which improved physical activity outcomes that could be carried out in any setting. Such techniques could be supported by educational professionals, potentially leading to sustained programme adherence and improved health outcomes.

**1. Introduction**

Globally poor dietary and exercise habits of adolescents and young people in the typically developing are adding to an increased prevalence of long-term health conditions (Fletcher et al., 2018). The World Health Organisation (WHO, 2017) predicts a 13% global mortality rise between 2002 and 2020 in four of the most prominent chronic diseases: type 2 diabetes (T2D), cardiovascular disease (CVD), cancer and chronic obstructive pulmonary disease (WHO, 2019). Physical activity programmes have demonstrated success in reducing the risk of developing long term health conditions and improving quality of life (QoL) in adolescents and young people (Ekelund et al., 2013; Granger et al. 2017; Gopinath et al. 2012; Yates et al. 2016). In addition, preventing the onset of long term conditions may lead to lower healthcare expenditure, such as reduced patient care and treatment costs. For example, costs associated with type 2 diabetes may be reduced by 40-60% (Gillies et al. 2007).

Poor dietary and exercise habits are also a concern for adolescents and young people with intellectual and developmental disabilities (IDD) as they are at significant risk of developing long-term health conditions such as diabetes, obesity and hypertension and are more likely to experience poorer physical health when compared to young people in the typically developing population (Krahn and Fox 2015; Truesdale and Brown, 2017; Allerton and Emerson, 2011). Further, genetic conditions such as Prader Willi and Down syndrome are likely to cause obesity at a young age, severely increasing the likelihood of T2D in later life (O’Shea et al., 2018), one of the four most prominent global long term health conditions. In addition, lower socio-economic status has been found to increase the risk of poor health by as much as 20-50% in adolescents and young people with IDD (Emerson and Hatton, 2007), further compounded by transport and membership costs, reduced opportunities for recreational exercise, lower health literacy, less access to healthy diets (Melville et al., 2008), and being over prescribed psychotropic medications (Trollor, Salomon, and Franklin, 2016). It is therefore imperative that people with IDD benefit from the same intervention approaches as those afforded to the typically developing population so that they may be supported to reduce the risk of developing long term health conditions and experience increased QoL, in accordance with the Adults with Incapacity Act (2000) and the Disability Equality Act (2010).

Recent literature reviews of the health of young people and adolescents with IDD have highlighted that whilst there are potentially significant benefits from the development of health intervention programmes, there remain methodological issues around recruitment and study design, which are often impacted upon by recruitment and delivery setting (Bertapelli et al. 2016, Jeng et al., 2017). Research has indicated that physical activity outcomes may be influenced by intervention settings, for example residential communities (Chow et al., 2016), schools (Haerens et al., 2008), and the workplace (Iwasaki et al., 2017). A key component of psychosocial interventions for people with IDD is social support, which is instrumental to a sense of self-efficacy (Maine et al., 2017), for example through facilitating recording and reflection of progress as well as positive feedback and reinforcement of key messages. While the type of support may vary depending on setting, it is important to consider which social settings are selected for intervention programmes, as these may act as mediators to the success of outcomes. This review therefore aimed to build an understanding of which recruitment and delivery settings are being used, and how these relate to intervention delivery contexts and techniques and healthy lifestyle outcomes, such as increased physical activity, reduced sedentary behaviour, and health literacy. Such an understanding may be used to guide the development of future interventions aimed at supporting adolescents and young people with IDD. Therefore, the aim of this review is to identify the intervention settings, techniques, and healthy lifestyle outcomes of health promotion programmes being provided to adolescents and young people with IDD.

**2. Methods**

**2.1. Search strategy**

A systematic search was conducted of PsycINFO, PubMed, CINAHL, ERIC, and the British Education Index electronic databases to identify relevant psychosocial and educational studies. Search terms included Intellectual disab\* OR learning disab\* OR developmental disab\* OR mental retardation AND young people or adolescents or teenagers or college students AND health intervention or health promotion or health prevention. Papers were included if the adolescents and young people were between 10 and 24 years, were written in English and were published over a 20-year period between January 1999 and January 2019. Additional age parameters were selected using the WHO (2013) definition of key terms, with adolescents as 10 to 19 years, and young people as 10 to 24 years.

**2.2. Study selection and data extraction**

As each search engine differed on age parameter settings, it was necessary to make further selections from abstracts and within methodology sections. A second reviewer repeated this procedure to validate the searches and selections. A third reviewer undertook an independent secondary evaluation of selected texts, and a final selection was made through consensus, as advocated by the Cochrane systematic review toolbox (2019). The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Moher, Liberati, Tetzlaff, & Altman, 2009) were adhered to through this process. Data extraction criteria was agreed by all reviewers through consensus (Table 1). Extraction was carried out by the first reviewer, and verified by the second, and involved spreadsheet entry of means and standard deviations of participant characteristics, study designs, methodology and outcomes, and key recommendations. The PRISMA diagram (Figure 1) outlines the selection process.

*Insert figure 1 here*

**2.3. Inclusion criteria**

Results were included where the following criteria were employed:

* Health promotion programmes that targeted adolescents and/or young people with IDD
* Study designs which included randomized controlled trials (RCTs) and feasibility studies
* Adolescents and young people were between 10 and 24 years of age
* English language only

**2.4. Exclusion criteria**

* Studies focusing on developmental disabilities only
* Studies outside of specified date range
* Full text not available

**2.5. Quality of evidence**

Quality of evidence was assessed by the first review using the Effective Public Health Practice Project (2008), a tool comprising a series of component ratings which include the representativeness of samples to populations, study design, control of confounding variables, validity and reliability of measures, and study drop-outs. This process was verified by a second reviewer.

**2.6. Synthesis of intervention techniques and outcomes**

Adopting guidelines of Kneale, Thomas, and Harris (2015), a logic model was constructed to visually explore interlinking components of the studies. Logic models increasingly play a useful role in the reviewing of interventions (Anderson et al., 2011), and in this review the model helped elucidate the complex relationship between the intervention settings, techniques, and outcomes.

*Insert Table 1 here*

**3. Results**

Data extracted from the studies are summarised in Table 1.

**3.1. Settings and locations**

Of the 16 studies identified, four were conducted in the U.S. (Chen et al., 2015; Curtin et al., 2013; Hubbard et al., 2015; Stanish and Temple, 2011), two each in Australia (Lennox et al., 2016; Shields et al., 2013) and Belgium (Boer et al., 2014; Elmahgoub et al., 2009), and one each in New Zealand (Hinkson et al., 2013), Poland (Jankowicz-Szymanska et al., 2012), Spain (Ordonez et al., 2014), The Netherlands (Kiewik et al., 2016), Taiwan (Wu et al., 2017), South Korea (Lee, Lee, and Song, 2016), the U.K. (Maine, Brown, Dickson, and Truesdale, 2019) and China (Kong et al., 2019).

**3.1. Participant characteristics**

The overall mean participant age was 17.7 (SD 2.5) years and ranged from 7 (Hinkson et al. 2013) to 39 (Maine et al. 2019) based on available data.

The mean percentage of female participants in studies was 46.7%, and included an all-female sample (Ordonez et al. 2014); removing this would provide a mean of 42.8%. Ethnicity was not reported in the studies, with the exception of Curtin et al. (2013) who reported a 4.8% Hispanic and 95% White sample. Down syndrome was the most commonly reported disability condition, and was the specific focus of four studies (Chen et al., 2015; Curtin et al., 2013; Ordonez et al., 2014; and Shields et al., 2013), and was further highlighted as a predominant condition amongst participants by Hinkson et al., 2013; Jankowicz-Szymanska et al., 2012; Stanish and Temple, 2011; Wu et al., 2017). This may reflect upon the genetic characteristics associated with Down syndrome, such as overweight and obesity, and cardiovascular conditions which can limit opportunity for physical activity (Emerson and Hatton, 2007). A range of other conditions described across studies as secondary included autism, fragile X syndrome, foetal alcohol syndrome (FAS), Prader-Willi syndrome, hydrocephalus, pervasive developmental disorder, Sotos syndrome, Steinert syndrome, and global developmental delay. However, the sizes of these subgroups were not commonly reported. These may have acted as additional barriers to implementing healthy lifestyles. However, as sizes of these subgroups were not commonly reported, it is difficult to assess the extent of their impact.

**3.3. Measured outcomes**

Measured outcomes (and significant results) are described below in the logic model (Figure 2)*.* The most commonly measured outcome was body composition (*N*=8), which included standardised measures of BMI, waist circumference, body fat mass, fat-free mass, skeletal muscle mass and body fat percentage (Boer et al., 2014; Elmahgoub et al. 2009; Kong et al., 2019; Ordonez et al., 2014; Stanish and Temple, 2011; Wu et al., 2017).

This was followed by physical fitness (*N*=5), which encompassed the maximal cardiopulmonary exercise test, and six-minute walk test (Boer et al., 2014; Elmahgoub et al. 2009; Hinkson et al., 2013); the sit-and-reach test, dominant hand grip test, and modified curl-ups (Stanish and Temple, 2011; Kong et al., 2018); and one minute sit-ups (Wu et al., 2017; Kong et al., 2016).

Other notable measured outcomes included balance, which was measured in five studies, and utilized measures including static balance and one-legged standing/unipedal stance test (Jankowicz-Szymanska et al., 2012, Wu et al., 2016, Lee et al., 2016; Kong et al., 2016). Strength (N=4) involved the sit-to-stand test, repetition maximum, hand grip strength, and muscle fatigue resistance (Elmagoub et al, 2009, Lee et al., 2016); dominant hand grip test and modified curl-ups (Stanish and Temple, 2011), and one-repetition maximum tests (Shields et al., 2013).

**3.4. Context and content**

The logic model (Figure 2) and associated table (Table 2) below, aligns recruitment and delivery context to intervention techniques and to statistically significant outcomes, thus providing a visual outline of the relationship between these study characteristics.

*Insert Figure 1 and Table 2 here*

The majority of the studies recruited participants from educational classroom-based settings (n = 11), yet more interventions took place in a gym setting (N= 8), than in classrooms (N = 5). This reflects on the prevalent intervention approach of using physical activity equipment such as stack weights and treadmills, for which a gym setting was necessary.

Classroom-based interventions took an educational approach, with a focus on diet, physical activity, and the benefits of medical check-ups, additionally enhanced by parental input. Decreased weight and increased physical activity levels were achieved as significant outcomes, as well as an increased likelihood of medical checks. The use of the gym lead to significant improvements in body composition, physical fitness, muscular strength, cardiovascular levels, and balance.

A sports laboratory (N=1) was another setting used and revealed that aerobic training led to decreased blood pressure, waist circumference and lipids, together with executive function changes. Additionally, a classroom-based intervention in a university room (N=1) was used for dietary and parental education leading led to lower body weight and increased physical activity.

**3.5. Recommendations**

Most studies made recommendations for future research and practice, with some exceptions (Elmahgoub et al. 2009, Shields et al. 2013). Six recommendations related to intervention modifications such as training for peer support (Stanish and Temple, 2011) and consultation with family and supporters (Curtin et al., 2013; Hinkson et al. 2013; Kiewik et al. 2016). Other recommendations were methodological, focusing on improving rigour through increased sample sizes (Chen et al., 2015; Kong et al., 2019) and longitudinal follow ups (Hubbard et al. 2015; Ordonez et al. 2014). Pertinent to this review, Hinkson et al. (2013) recommended that the schools were appropriate settings for these interventions, while Hubbard et al. (2015) advocated for educational settings beyond schools, a view further supported by Maine et al. (2019) who recommended continued delivery in further education institutions.

**3.6. Quality evaluation**

Study quality is summarized in Table 3. The assessed quality of the studies was not high, with three received ‘Strong’ global ratings (Boer et al., 2014; Chen et al., 2015; Shields et al., 2013). Individual component ratings are provided in separate tables, in the supplementary materials. The EPHPP tool does not heavily penalize on study design. Small sampled feasibility studies may therefore be awarded a similar overall rating to cluster RCTs. As RCT studies were a minority in the present review (n=5, Lee et al., 2016; Lennox et al., 2016; Kiewik et al., 2016; Kong et al., 2019; Shields et al., 2013), the EPHPP was a suitable tool for providing a balanced comparison across studies. The majority of ‘Weak’ component ratings (n=8) were due to study drop-out rates, highlighting a common issue with participation adherence. The second most common ‘Weak’ component ratings were due to ‘Confounders’ where studies had not reported balancing of baseline demographics. This was noted in five of the 16 studies (Curtin et al., 2013; Hinkson et al., 2013; Hubbard et al., 2015; Stanish and Temple 2012; Wu et al., 2017) (Table 4).

*Insert Table 3 here*

**4. Discussion**

This is the first systematic review of the recruitment settings, delivery contexts, and intervention techniques and outcomes of health promotion programmes aimed specifically at adolescents and young people with IDD. The included studies mainly recruited participants from schools (mean age 17.7 years). In recruiting a young age group, the studies steered towards a preventative agenda; reducing the risk of unhealthy lifestyle-related diseases later in later life. This approach is advocated in the typically developing population and is a key initiative of the Medical Research Council (2019). However, despite recruitment from schools, interventions were typically physical activity-based and took place in settings with sports facilities, such as gyms, where equipment facilitated successful outcomes. These were primarily improved muscle strength, cardiovascular fitness, and balance. However, the long-term impact of gym-based interventions aimed at young people with IDD in schools may be limited given that the school leaving age is usually around 18 years of age, thus negating the possibility of sustaining these health benefits and outcomes. It could be further argued that while the gym settings may be the most appropriate in terms of achieving targeted outcomes, positive health outcomes were achieved irrespective of the setting, which is a significant finding warranting further attention.

Other barriers, including lower socio-economic status and transport and membership costs, significantly reduced opportunities for adolescents and young people with IDD accessing sports facilities (Emerson and Hatton, 2007; Emerson and Baines, 2010). Indeed, Coates et al. (2017) described similar issues leading to low levels of continued adherence to interventions. It is therefore arguable that day-to-day settings, such as vocational or educational placements, may carry fewer barriers and increase the likelihood of long-term adherence, yet improving access to gyms and sports centres has to be part of the preventative global health agenda to ensure that adolescents and young people with IDD can avail of the same opportunities as their peers, thereby sustaining and maintaining positive health outcomes.

This finding may also be true of the three studies which took place in research settings (Boer et al., 2014, Chen et al., 2015, and Curtin et al., 2013), which may be removed from everyday activities. Notably, not all of the physical activity techniques required equipment such as stretching and core strength training. Therefore, it may be possible to research the impact of these techniques in a setting outside of a gym.

Classroom-based interventions mainly targeted diet and physical activity enhanced by social support, and statistically significant outcomes in weight loss and increased physical activity were identified. However, recruitment of participants with IDD has been reported as challenging, due to barriers such as care staff attitudes and organisational policies (Bossink et al., 2017; Cartwright et al., 2017). In such a pragmatic sampling approach, researchers would have approached single gatekeepers in the first instance to gain approval to access large groups, rather than individuals. This setting may therefore be advantageous in terms of numbers, and extend the possibility of recruiting larger samples through multi-centre recruitment.

The majority of the health promotion programmes for adolescents and young people in the general population has been conducted in school settings. A meta-analysis (Sobol, Rabinowitz, and Gross, 2013) of 32 RCTs of intervention programmes which reduced obesity in a school setting found that more recent studies were more effective as these were longer and involved parental contribution. In terms of intervention outcomes, 78% (25/32) of programmes increased physical activity; 62.5% (20/32) reduced sedentary behaviour; 81% (26/32) increased a healthy diet; and 78% (25/32) reduced unhealthy diet, which are similar to the present review. However, these outcomes were primarily achieved though educational sessions, rather than physical activity techniques such as strength and aerobic training, which led to successful outcomes in the present review. A subsequent step would be to explore these techniques in an educational setting and ascertain their applicability to adolescents and young people with IDD.

In addition to settings and techniques, study outcome measures are likely to have influenced the choice of setting and intervention technique, and as such may have played a mediator role. For example, whilst physical fitness and strength outcomes utilised a wide range of measures which were often not context dependent and could be thus be carried out in accessible settings, cardiovascular and metabolic fitness outcomes occasionally required the use of laboratory equipment. This may be regarded as a limitation in this review as it is not fully clear the extent to which outcome measures rather than settings or techniques are responsible for significant results. However, the logic model and table highlights that the most commonly reported outcomes and significant results are likely to be aligned to intervention techniques.

As this review provides evidence of a significant focus on avoiding unhealthy lifestyles in adolescents and young people, an educational setting beyond school could be considered in future research (Hubbard et al., 2015). With the exception of Maine et al. (2019) who explored a further education college setting, all education setting studies were school-based. In Scotland, for example, 6% of adolescents and young people with IDD (aged 16–34 years) were in further education during 2017 (Scottish Commission of Learning Disabilities, 2017), which is a relatively unexplored area in healthy lifestyle intervention research. As the mean age of further education students ranges from 16-26 years (Association of Colleges, 2018), it is evident that studies focussing on preventing chronic diseases in adolescents and young people with IDD have thus far not adequately addressed their specific health needs. These findings provide a rationale for further research to be conducted in further education colleges supporting people with IDD. A UK Department of Education commissioned review (Carroll et al., 2017) highlighted that the majority of evidence for IDD curriculum approach comes from schools, rather than further education colleges, and that there is a dearth of health research in this area, with focus instead directed at pedagogy and challenging behaviour, despite health being a component of the life skills curriculum. It therefore follows that there is a need to identify what healthy lifestyle messages are currently being delivered, and how these could be enhanced through an evidence base. As with the interventions delivered within a school setting highlighted in this review, components which provide education on diet are also of key importance. These may also be an aspect of current further education life skills curriculum, and further research is required in this setting.

**5. Conclusions**

Knowledge acquired from two decades of research on healthy lifestyle intervention programmes for adolescents and young people with IDD is limited, due to poor methodological concerns such as small sample sizes and a lack of robust study designs. However, programmes which focused on increased strength and aerobic training, and dietary education demonstrated some improvements and offered potential pointers for successful lifestyle modification in young people with IDD. This review has highlighted that intervention settings have a close relationship with techniques and should therefore be carefully selected. Physical activity training may not require physical activity settings. Educational settings may provide accessibility and social support, and a research gap in the further education college context has been identified. Therefore, further research might consider physical activity training sessions within further education college settings as part of the preventative health strategy required to support intervention techniques and positive health outcomes for adolescents and young people with IDD.

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**Conflict of Interest**

The authors have no conflict of interest to declare.

**Table 1. Study characteristics**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **Aims/design** | **Intervention setting and techniques** | **Participants** | **Measures** | **Results** | **Recommendations** | **Global EPHPP rating** |
| Elmahgoub et al. (2009)  Belgium | Investigating the effects of combined exercise training on physical health, physical fitness and lipid profile in adolescents with ID  Powered: No  Randomized: Yes  Control: Yes | Gym  Strength training using stack weights  Aerobic training using cycling and steps | Special education school  Adolescents with IDD  (*N* = 30)  Age 14-22 years  Gender not specified  Disability:  non-specific: 26.7%;  Fragile X 26.7%;  Autism 46.7%  Ethnicity: Not specified | Height, weight, wait circumference  Lipid profile  Cardiovascular fitness  Sit to stand test  Hand grip strength  Muscle fatigue test | 100% attendance  Significant improvements across all outcomes (P = 0.05) | None stated | Moderate |
| Stanish and Temple (2011)  U.S. | Evaluation of efficacy of a peer-guided exercise programme  for adolescents with intellectual disability  Powered: No  Randomized: No  Control: No | Gym  Strength training using stack weights  Aerobic training using machines  Physio-guided stretching and core strength training  Peer support | YMCA (community setting)  Young people and people and adolescents with ID (*N* = 20)  Age: 15 -21 (mean 17.8, SD 1.6) years  Females 50%  Disability: Down syndrome, Williams syndrome, cerebral palsy and unspecified (group numbers not provided)  Ethnicity: Not specified | Attendance and exercise engagement:  Programme attendance and monitored by fitness instructors | 89.5% attendance  All quantitative changes statistically unclear or insignificant  Qualitative data included themes of health gains, social gains and programmes which fit | Specific programme improvements:  Additional time to complete exercises; extended overall programme; use of heart rate monitors to objectively monitor exercise intensity;  training for peer support | Weak |
| Jankowicz-Szymanska et al. (2012)  Poland | Exploring the effects of a three-month sensorimotor training programme on static balance in young people with ID  Powered: No  Randomized: Yes  Control: Yes  Powered: Yes  Randomized: Yes  Control: Yes | Gym  Balance training using rehabilitation balls, air pillows, exercises in balance positions | Special education care centre  Young people with mild ID (*N* = 40)  Age: 16-18 (mean 16.8) years  Females: 50%  Disability: Down syndrome was the cause of mild retardation (group numbers not provided)  Ethnicity: Not specified | Height, weight, BMI  Static balance | Attendance rates not reported  Improvements in experimental group were noted but not significant | Exercise programmes for persons with IDD should be supplemented by sensorimotor exercises | Moderate |
| Curtin et al. (2013)  U.S. | Assessing impact of parental education in a weight loss intervention for young people with ID. | Home/research centre  Diet plan made in consultation with parents  Parents instructed on diet implementation  Dietician-led nutrition education sessions  Therapeutic recreation-led physical activity education sessions | University  Young people with Down syndrome (*N* = 21)  Age: 16-18 (mean 20.5, SD 3.2) years  Females: 81%  Disability: Down syndrome: 100%  Ethnicity:  White: 95%  Hispanic: 4.8% | Mean changes in levels of physical activity, weight and percentage of body fat  Dietary behaviours (consumption of fruits and vegetables) | Lower body weight in intervention group; P = .005)  Increases in physical activity in intervention ﻿  (P = 0.002)  Dietary changes not significant | Monthly individual counselling  Focus on aerobic activities to decrease sedentary behaviour  Utilization of common goals across stakeholders | Moderate |
| Shields et al. (2013)  Australia | Investigating the effects of a student-led resistance training programme in adolescents and young people with Down syndrome  Powered: No  Randomized: Yes  Control: Yes | Gym  Resistance training using weight machines | Community Gym  Adolescents and young people with Down syndrome (*N* = 68)  Age: mean 17.9, SD 2.6 years  Females: 41%  Down syndrome: 100%  Ethnicity: Not specified | Work performance (Simulated work test)  Muscle strength (one-repetition maximum force generation tests)  Physical activity levels (Accelerometer)  Social activities (Control group) | 92% Attendance  Significant increase over social group in muscle strength (95% CI 3–11; SMD 0.8)  and physical activity (95% CI 5–112; SMD 0.8) in later weeks  No difference in work performance | None stated | Strong |
| Hinkson et al. (2013)  “MEND” (Mind, nutrition, Do it)  New Zealand | Evaluating effectiveness of a program managing weight through changes in physical activity and nutrition behaviours in overweight and obese NZ children and youth with IDD  Pre- and post- measures  Powered: No  Randomized: No | School  Classroom based physical activity sessions | Special needs schools  Children and youth with IDD (*N* = 17)  Aged 7+ years  Females 41%  Disability:  global developmental delay 23.5%;  autism 41.2%;  Down syndrome  11.8%;  intellectual disability:  17.6%  Ethnicity: Not specified | Diet and nutrition questionnaire  Parent nutrition questionnaire  Ambulatory activity  Height, weight, BMI  *t*-tests for all above  Semi-structured interviews | Attendance rates not reported  All quantitative changes statistically unclear or insignificant   Attendance rates not reported  Qualitative data included themes of health gains, social gains and programmes which fit | Programme ﻿specifically tailored to the needs of young people with IDD  Focus on healthy living rather than obesity management  ﻿Consultation with family and community important  School is most suitable setting  Information should be tailored to individuals and delivered by those with IDD specialist training  Appropriate required to determine physical activity, nutrition and health behaviours in young people with IDD  Future research should consider qualitative and Quantitative data plus cost analysis | Weak |
| Ordonez et al. (2014)  Spain | Assessing the influence of aerobic training on obesity in women with Down syndrome.  Powered: No  Randomized: Yes  Control: No | Gym  Aerobic training using treadmills | Community support groups  Women with Down syndrome (*N* = 20)  Age: 18-30  Females: 100%  Down syndrome: 100%  Ethnicity: Not specified | Body fat % and distribution  Anthropometric measures, including plasmatic levels | Attendance rates not reported  Significant reductions in plasmatic levels | Robust, longitudinal studies are required | Moderate |
| Chen et al. (2015)  U.S. | Investigating the impact of a single exercise intervention on executive function in young people with Down syndrome  Powered: No  Randomized: Yes  Control: Yes | Laboratory  (Aerobic training using treadmills) | Recruited from Special Olympics team (took place in sports lab)  Young people with Down syndrome (*N* = 20)  Age: mean 23  Females 30%  Down syndrome: 100%  Ethnicity: Not specified | Measures of executive function-related behaviours | 95.2% Attendance  Non-significant changes in response times  Significant improvements in inhibition | Future studies should use larger sample sizes, controlled exercise intensity, physical fitness, testing time after intervention and the time of the test (e.g. optimal time of day for executive processing). | Strong |
| Boer et al. (2014)  Belgium | Evaluating the effect of sprint interval training on metabolic and physical fitness in adolescents and young people with ID  Powered: No  Randomized: Yes  Control: Yes | Special education schools (in physio lab)  Aerobic training using treadmills | Special education schools  Adolescents and young people with ID (*N* = 54)  Age: mean 17, SD 3.0  Females 40.7%  Disability:  fragile x syndrome, foetal alcohol syndrome, Prader-Willi syndrome, hydrocephalus, pervasive developmental disorder, Sotos syndrome, Steinert syndrome (numbers not specified)  Ethnicity: Not specified | Height, weight, BMI, waist circumference  Physical activity (cardiopulmonary using cyclo-ergometer)  Blood pressure and lipid profile  6 minute walk test  Sit to stand test  Muscle fatigue resistance | 85% Attendance  Significant reductions in intervention group in waist circumference (P < 0.01); blood pressure; insulin levels (P < 0.01); lipids (LDL only - P < 0.01)  Significant increases in cardiopulmonary measures (P < 0.01) | Further research with sprint interval and resistance training should be conducted  Similar research could be carried out with homogenous groups such as people with DS or Fragile X | Strong |
| Hubbard et al. (2015)  U.S.  “Smarter Lunchroom” | Assessing impact of a school based diet intervention programme  Powered: No  Randomized: No  Control: No | Residential school  Social story preparation  Environmental changes (layout of canteen food options) | Specialized residential school (private)  Students with IDD (*N* = 43)  Age: 11-22 (mean 18.3, SD 2.5)  Females 51%  Disability: Not specified  Ethnicity: Not specified | Digital photography of foods: selection and plate waste | 100% Attendance  Significant increases in healthy foods, including whole grains (P = 0.005) and fruits (P = 0.008).  Significant decreases in fruit ((P = 0.04) and vegetables (P = 0.03). | Future research should assess long-term dietary change adherence and explore programme in other educational settings | Weak |
| Kiewik et al. (2016)  Netherlands  “PREPARED ON TIME” | Evaluating efficacy of an e-learning program for students with ID in secondary special-needs schools and examining tobacco and alcohol use for this population  Powered: No  Randomized: Yes  Control: Yes | Classroom based  Educational sessions which focus on attitude–social inﬂuence–efﬁcacy mode | Special needs schools  Students with mild and borderline ID (*N* = 254)  Age: 12-15 (mean 13.6)  Females 42.4%  Disability: Not specified  Ethnicity: Not specified | Baseline questionnaires on lifestyle behaviours | Attendance rates not reported  Respondents had initiated smoking (49%) and drinking (75%) beyond expectations  “PREPARED ON TIME” did not affect the behavioural determinants | Intervention should include additional training such as refusal and social skills.  Frequent repetition of didactic material  Parental involvement | Moderate |
| Lennox et al. (2016)  Australia  “Ask health diary” and “Comprehensive Health Assessment Program (CHAP)” | Assessing a health intervention package promoting health and detecting disease in adolescents with ID  Powered: Yes  Randomized: Yes  Control: No (randomization of school selection) | Classroom  Health promotion diary with education sessions | Special education schools  Adolescents with ID (*N* = 592  Age: mean 15.5, SD 1.6  Females: 45.4%  Disability: Not specified  Ethnicity: Not specified | CHAP compared to previous years GP records, with vision and hearing as primary outcomes | 38% Attendance  Testing more likely in intervention group for vision (odds ratio [OR] 3.3; 95% confidence interval [CI] 1.8–6.1); hearing (OR 2.7; 95% CI 1.0–7.3); blood pressure change (OR 2.4; 95% CI 1.6–3.7); and weight recorded (OR 4.8; 95% CI 3.1–7.6) | Programme should be delivered to adolescents  Long term health risk reduction should be studied | Weak |
| Wu et al. (2017)  Taiwan | Assessing effects of a cross-circuit training intervention program for obese or overweight students with ID  Powered: No  Randomized: No  Control: Yes | Gym  Cross-circuit training  Treadmill, step machine, cross trainer, and stationary bicycle | Special education school  Adolescents with ID (*N* = 43)  Age: 13-19 (mean 16.9, SD 1.35)  Females 42%  Disability: reported as secondary conditions to ID -  Down syndrome: 16.3%, vocal dysfunction: 9.3%, autism: 6.9%, mental disorder: 2.3%  Ethnicity: Not specified | Height, weight, heart rate, body composition, dynamic balance  1-min sit-ups, anaerobic test  Cardiorespiratory fitness | Attendance rates not reported  Significant differences in weight, BMI, body fat mass, and body fat percentage between normal weight group other groups (p < 0.05). | Weight training interventions aimed at muscle strength improvement should be provided to adolescents with ID  Future studies should include eyes-closed balance training, together with vestibular and proprioception stimulation to improve the balance performance of people with ID | Weak |
| Lee et al. (2016)  South Korea | Exploring the effects of balance training on postural balance, gait, and functional strength in adolescents with intellectual disabilities  Powered: No  Randomized: Yes  Control: Yes | Not specified  Balance training using balls, balloons and foam on balance mats | Special education school  Adolescents with ID (*N* = 32)  Age:14-19 (mean 16.9, SD 1.70)  Females 43.8%  Disability: Not specified  Ethnicity: Not specified | Balance (postural sway and one leg test)  Gait  Sit-to-stand test | ﻿93.8% Attendance  Significant improvements in postural balance and functional strength in intervention group (p < 0.05) | Longitudinal follow-ups. | Moderate |
| Maine et al. (2019)  U.K. | Assessing feasibility of delivering a T2D prevention programme in FE colleges using process evaluation.  Powered: No  Randomized: No  Control: No | Two FE colleges  Educational sessions promoting increased ambulatory activity | FE colleges  Young people with ID (*N* = 48)  Age: Range 18–39 years,  Mean 20.9 (SD 5.02)  Females:  37.5%    Disability: Not specified  Ethnicity: Not specified | Focus group feedback (students and educators)  Attendance rates  Baseline ambulatory and anthropometric measures  International physical activity questionnaire | 96% participation rate.  Educational sessions positively  received, and some short‐term impact was described  62.5% of participants were obese or overweight  High levels of physical inactivity | Adapted version of programme to be trialled with FE college educators before wider trial | Moderate |
| Kong et al. (2019)  China | Investigating effects of Tai Chi on  physical fitness among children and adolescents with ID.  Powered: No  Randomized: No  Control: Yes | Indoor sports hall  Tai chi exercises modified for population  One Tai chi (TC) group, one aerobic exercise (AE) and one control | Two local special schools and one integrated school  Young people with ID (*N* = 66)  Age: Mean 14.9 SD 2.1  Females  4%  Disability: Not specified  Ethnicity: Not specified | Heart rate monitoring  Pedometer step-count  Anthropometric measures (height, weight, skinfold, waist and hips)  Flexibility, balance, coordination,  grip strength, leg power, muscular endurance, and cardiorespiratory fitness | 60% Attendance  AE group: Significant changes in body mass index (p = 0.006, d = 0.11); sit-ups (p = 0.030 and d = 0.57);  6-min walk test (p = 0.005, d = 0.89);  Vertical jump (p = 0.048, d = 0.41);  Lower-limb coordination (p = 0.008, d = 0.53), and upper-limb coordination (p = 0.048, d = 0.36)  TC group: significantly greater  improvements on balance compared to the control group (p = 0.011) | Further rigorous studies, larger sample sizes to validate findings. | Strong |

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| --- | --- |
| **Study number** | **Authors** |
| 1 | Elmahgoub et al. (2009) |
| 2 | Stanish and Temple (2011) |
| 3 | Jankowicz-Szymanska et al. (2012) |
| 4 | Curtin et al. (2013) |
| 5 | Shields et al. (2013) |
| 6 | Hinkson et al. (2013) |
| 7 | Ordonez et al. (2014) |
| 8 | Chen et al. (2015) |
| 9 | Boer et al. (2014) |
| 10 | Hubbard et al. (2015) |
| 11 | Kiewik et al. (2016) |
| 12 | Lennox et al. (2016) |
| 13 | Wu et al. (2017) |
| 14 | Lee et al. (2016) |
| 15 | Maine et al. (2019) |
| 16 | Kong et al. (2019) |

**Table 2. Study number matrix**

**Table 3. EPHPP global ratings**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Study | Representativeness | Design | Confounders | Data Collection method | Drop-outs | Global rating |
| Elmahgoub et al. (2009) | Moderate | Moderate | Strong | Strong | Weak | Moderate |
| Stanish and Temple (2012) | Moderate | Moderate | Weak | Strong | Weak | Weak |
| Jankowicz-Szymanska et al. (2011) | Moderate | Moderate | Strong | Strong | Weak | Moderate |
| Curtin et al. (2013) | Moderate | Moderate | Weak | Strong | Strong | Moderate |
| Shields et al. (2013) | Moderate | Strong | Strong | Strong | Strong | Strong |
| Hinkson et al. (2013) | Moderate | Moderate | Weak | Strong | Weak | Weak |
| Ordonez et al. (2014) | Moderate | Strong | Strong | Strong | Weak | Moderate |
| Chen et al. (2015) | Moderate | Strong | Strong | Moderate | Moderate | Strong |
| Boer et al. (2014) | Moderate | Moderate | Moderate | Strong | Strong | Strong |
| Hubbard et al. (2015) | Weak | Moderate | Weak | Moderate | Strong | Weak |
| Kiewik et al. (2016) | Moderate | Strong | Strong | Weak | Strong | Moderate |
| Lennox et al. (2016) | Weak | Strong | Strong | Strong | Weak | Weak |
| Wu et al. (2017) | Moderate | Moderate | Weak | Strong | Weak | Weak |
| Lee et al. (2016) | Moderate | Strong | Strong | Strong | Weak | Moderate |
| Maine et al. (2019) | Moderate | Moderate | Weak | Strong | Strong | Moderate |
| Kong et al. (2019) | Moderate | Strong | Strong | Strong | Mod. | Strong |