Dual-Energy X-Ray Absorptiometry to Measure the Effects of a Thirteen-Week Moderate to Vigorous Aquatic Exercise and Nutritional Education Intervention on Percent Body Fat in Adults with Intellectual Disabilities from Group Home Settings

by

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People with intellectual disability are more likely to be obese and extremely obese than people without intellectual disability with rates remaining elevated among adults, women and individuals living in community settings. Dual-energy X-ray absorptiometry measured the effects of a 13-week aquatic exercise and nutrition intervention on percent body fat in eight adults with intellectual disabilities (aged 41.0 ± 13.7 yrs) of varying fat levels (15%-39%) from two group homes. A moderate to vigorous aquatic exercise program lasted for the duration of 13 weeks with three, one-hour sessions held at a 25m pool each week. Nutritional assistants educated participants as to the importance of food choice and portion size. A two-tailed Wilcoxon matched-pairs signed-ranks test determined the impact of the combined intervention on body fat percentage and BMI at pre and post test. Median body fat percentage (0.8 %) and BMI (0.3 kg/m²) decreased following the exercise intervention, but neither were statistically significant, p = .11 and p = .55, respectively. The combined intervention was ineffective at reducing percent body fat in adults with intellectual disability according to dual-energy X-ray absorptiometry. These results are in agreement with findings from exercise alone interventions and suggest that more stringent nutritional guidelines are needed for this population and especially for individuals living in group home settings. The study did show that adults with intellectual disability may participate in moderate to vigorous physical activity when given the opportunity.

Key words: physical activity, diet, body composition, swimming, obesity.

Introduction

People with intellectual disability (ID) are more likely to be obese and extremely obese than people without ID with rates remaining elevated among adults, women and individuals living in community settings (Rimmer and Yamaki, 2006). Research indicates this may be due in part to unequal access to health promotion or preventative services (Krahn et al., 2006). Exercise has been the catalyst for decreased obesity among individuals without ID (Ross and Janssen, 2001) and there is a possibility that exercise training of sufficient frequency, intensity and duration may increase the caloric expenditure of individuals with ID as well. However, Draheim et al. (2002) found no adults with ID over the age of thirty reported participation in vigorous physical activity and research documents the increased likelihood of inactivity among this population (Havercamp et al., 2004).

Despite the benefits of physical activity, limited findings thus far including a recent study adopting aquatic exercise suggest that exercise training alone may not be effective at reducing the percent body fat of individuals with ID (Pitetti

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and Tan, 1991; Pommering et al., 1994; Ozmen et al., 2007; Casey et al., 2010). Few studies have produced change (Ordonez et al., 2006) and this pattern may be partially explained by inconsistent methods of measurement as only the latter study used a complex tool such as dual-energy X-ray absorptiometry (DXA) to gauge the effectiveness of exercise training. DXA minimizes bias based on a range of characteristics and has produced accurate and precise measurements in individuals with high levels of body fat (Prior et al., 1997; Lazzer et al., 2008). DXA scans do not require active participant involvement, which is an important consideration when conducting research with individuals with ID (Avesani et al., 2004).

Another possible explanation may be the lack of attention studies have paid to eating behaviours. Individuals with ID have been shown to make unhealthy eating choices when given the opportunity (Starr and Marsden, 2008). This phenomenon has been connected to difficulties with memory, comprehension, dexterity, literacy, and communication, which make recalling, recording and quantifying food consumption challenging (Humphries et al., 2009). Approximately two-thirds of adults with ID live in community based settings such as group homes (Prouty and Lakin, 2005) and the daily diet of these residences has been shown to include nutrient poor foods and dietary fats (Humphries et al., 2004). Therefore, in addition to sedentary lifestyles, inadequate nutrition and food habits may be partly responsible for high rates of obesity in adults with ID (Draheim et al., 2002). Bertoli et al. (2006) recommended nutritional counselling and assessments in order to establish a healthier lifestyle while Humphries et al. (2009) concluded that dietary guidelines, healthy goal setting, and nutritional education for both staff members and individuals living in group homes are of paramount importance in the fight to combat obesity.

Only Croce (1990) has combined an exercise training intervention with a diet intervention by requiring a weekly reduction of 3500 kcal from participants’ diet below what is needed to maintain body weight. Despite lacking an educational component, his intervention contributed to a decrease in percent body fat according to skinfold testing even if it included only three men with ID all under the age of thirty from residential settings. No information exists as to the effectiveness of such a combined intervention on individuals from group homes, adult women or on adults in general over the age of thirty.

Therefore, the purpose of this study is to use DXA to assess the effects of a thirteen-week-aquatic exercise and nutrition intervention on percent body fat in adults with ID of varying fat ranges (15%-39%) from two group homes. Body mass index (BMI) will also be assessed. The study will also seek to implement moderate to vigorous activity (at 60-80% of their theoretical maximum heart rate) for adults with ID. It is hypothesized that the combined intervention will significantly reduce percent body fat and BMI among participants. It is also hypothesized that adults with ID will be able to exercise at sufficient heart rate ranges.

Material and Methods

Participants

Table 1 shows the demographics of eight participants (two women, six men) with ID (aged 43.0 ± 13.9 yrs) recruited from two small group homes from within the local community. Researchers outlined testing procedures, potential benefits, associated risks and the time required for the study in an information letter and discussion session prepared for adults with ID and their parents and/or guardians - who provided signed informed consent. Adults were excluded from the study if they had any underlying health condition that prevented participation or if they belonged to any other exercise training or diet intervention programs. Procedures were in accordance with the institution’s research ethics board and with the Helsinki Declaration of 1975, as revised in 2000.

Procedures

Protocol

Participants’ percent body fat was measured immediately before and after the intervention period. Participants were asked not to consume water or food two hours prior to testing and told to wear a standardized light cotton shirt and shorts containing no metal to minimize clothing absorption. Height and weight

Participants’ height, without footwear,
was measured to the nearest 0.1cm using a stadiometer (Tanita HR-200) while standing with her or his head straight forward and eyes fixed in the Frankfort plane. Each participant’s back and shoulders remained directly against the wall with feet together flat on the floor. Weight was assessed to the nearest 0.1kg using a calibrated digital scale. Body mass index was calculated by dividing weight (kg) by height (m) squared.

Dual-energy x-ray absorptiometry

DXA Hologic QDR-1000W Whole Body Bone Densitometer (Version 6.10b) performed all scans to assess percent body fat. Technicians calibrated the DXA scanner on each day of testing to ensure reliability using an anthropometric phantom (Hologic X-CALIBER Model DPA/QDR-1b) of known densities.

The same technicians performed every scan following manufacturers recommended guidelines. Each participant laid down for approximately 20mins to complete their personal scans. Researchers analyzed DXA scans using Software Version 6.10b.

Exercise intervention

Aquatic exercise, consisting of aqua jogging, water polo and lap swimming, was held in a 25m pool (78°F) in the presence of certified lifeguards for one-hour three times per week over the duration of 13 weeks. Training sessions were led by an aquatic instructor and seven research assistants who adopted motivational strategies including music, verbal reinforcement and physical praise. The duration of intense exercise increased from 15 to 25 to 35 minutes over four-weekly increments. Endurance exercise was preceded by a 10-minute light aerobic warm up and ended with a 10-minute low intensity recovery period. Participants were instructed to exercise at 60-80% of their theoretical maximum heart rate although adults with type-two diabetes (n=2) exercised between 40-70% (Pitetti and Fernhall, 2001). Researchers tested heart rates when participants arrived at the facility and at 15minute intervals during each training session using Polar Heart Rate T31 transmitters (CE 537) and Polar Heart Rate A1 wrist receivers (Polar Electro Inc., 2008) to ensure that appropriate intensity levels were being maintained. Researchers ensured that 15g of carbohydrates without fat was readily available for participants with diabetes at each exercise session while additional equipment (e.g. aqua jogging belts, flutter-boards) was made available to promote continued participation.

Table 1

Demographic Information including Weight, BMI and Percent Body Fat at Pre and Post-Test

| Measure | Pre-test | Post-test |
|---------|----------|-----------|
|         | Age (yrs) | Gender | Disability | Weight (kg) | BMI(kg/m²) | %BF | Weight (kg) | BMI | %BF |
| 1       | 28       | M      | NS         | 66.8       | 25.6       | 18.8 | 61.2       | 23.4 | 16.9 |
| 2       | 33       | M      | DS         | 68.4       | 28.1       | 26.1 | 69.0       | 28.4 | 26.7 |
| 3       | 51       | M      | DS         | 78.4       | 29.2       | 23.6 | 74.2       | 27.6 | 20.2 |
| 4*      | 57       | F      | DS,ED      | 62.2       | 34.2       | 37.6 | 60.8       | 34.0 | 37.5 |
| 5*      | 57       | F      | DS         | 73.2       | 28.4       | 36.7 | 73.8       | 28.6 | 36.4 |
| 6       | 45       | M      | NS         | 75.6       | 26.6       | 35.2 | 72.2       | 25.6 | 33.1 |
| 7       | 52       | M      | DS,ED      | 53.8       | 23.3       | 15.0 | 54.8       | 23.7 | 15.0 |
| 8       | 21       | M      | NS         | 110.6      | 42.1       | 38.6 | 110.6      | 42.1 | 38.1 |
| Mean    | 41.0     | ----- | -----      | 74.9       | 29.7       | 28.7 | 73.3       | 29.2 | 28.0 |
| St. Dev.| 13.7     | ----- | -----      | 15.6       | 5.9        | 9.0  | 16.0       | 6.2  | 9.5  |

ID, Intellectual disability; DS, Down syndrome; NS, No known syndrome; ED, Early-onset dementia; %BF, Percent body fat; *Type-two diabetes
### Table 2

**Participants’ Target Calorie Restriction per Week during Intervention**

| Participant | Age (yrs) | C1 (kJ) | C2 (0.032 Cal/lb/min) | C3 (kJ) | C4 (kJ) |
|-------------|-----------|---------|-----------------------|---------|---------|
| 1           | 28        | 15430   | 141                   | 3075    | 12354   |
| 2           | 33        | 15800   | 144                   | 3065    | 12764   |
| 3           | 51        | 18110   | 165                   | 3002    | 15108   |
| 4*          | 57        | 14368   | 131                   | 3105    | 11263   |
| 5*          | 57        | 16909   | 103                   | 3035    | 13874   |
| 6           | 45        | 17463   | 160                   | 3020    | 14443   |
| 7           | 52        | 12427   | 113                   | 3158    | 9269    |
| 8           | 21        | 25548   | 234                   | 2797    | 22750   |

C1: Calories required to be restricted from diet to maintain body weight  
C2: Theoretical calories burned during intervention  
C3: Weekly calories required to be restricted from diet  
C4: Target caloric consumption per week  
*Type-two diabetes

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**Nutrition Intervention**

Six research assistants led mandatory weekly counselling sessions aimed at educating group home directors, workers and participants as to the importance of portion size and food nutrition. These educational sessions targeted decision makers at all levels responsible for ordering, preparing and consuming meals during the intervention period. Researchers adhered to health promotion strategies found in *The Down Syndrome Nutrition Handbook*, designed by a nutritionist specializing in intellectual disability (Medlen, 2002). We targeted a weekly reduction in all participants’ caloric intake below what was required to maintain current body weight according to the equation: weight (kg) x 33 Calories/kg (Macedonio, 1984). At a reduction rate of 3500 kcal per week, the study hypothesized that participants would experience a weight loss of approximately 1 lb. or 0.45 kg per week (Medlen, 2002; Croce, 1990). Table 2 presents participants’ hypothetical calorie restriction targets. Participants were taught to maintain the reduced calorie-diet with the help of careful food selection and educational methods promoted throughout the course of the study period. Researchers recognize the inability to prescribe and measure energy intake individually remained a weakness of the nutrition intervention, but this was deemed beyond the scope of this exploratory study (Gately et al., 2000).

**Statistical Analysis**

Given the small sample size (N=8), we assumed that standard normality tests (Shapiro-Wilk, D’Agostino-Pearson, or Kolmogorov-Smirnov) would not have sufficient power to detect if the data departed significantly from a normal distribution. Therefore, we used a two-tailed Wilcoxon matched-pairs signed-ranks test to determine the impact of swim training on body fat percentage, heart rate and BMI in individuals with ID. The Wilcoxon matched-pairs signed-ranks test is a non-parametric alternative to the paired-sample t-test, which does not require that the data follow a normal distribution (Altman, 1991; Jackson, 2008) and has been used recently in repeated measures designs with small sample size (Tepas III et al., 2010). We set statistical significance at p < .05 and applied the software package GraphPad Prism 3.03 (GraphPad Software, Inc, La Jolla, CA), which provides an exact p-value calculation for the Wilcoxon matched-pairs signed-ranks test.

**Results**

Following the 13-week exercise
intervention, a 0.8 % median decrease in body fat percentage with a range from -3.4 % to 0.6 % was observed. The results of the Wilcoxon matched-pairs signed-ranks test indicate that this increase was not statistically significant, \( p = .11 \) (exact) (Figure 1). There was a negligible reduction in median BMI from 28.3 to 28.0 kg/m², which also failed to reach statistical significance, \( p = .55 \) (exact) (Figure 2). Table 3 presents heart rate data from participants during the exercise intervention. There was no significant reduction in exercising heart rate from pre-test to post-test across all participants.

**Discussion**

Researchers used DXA to measure the impact of a 13-week aquatic exercise and nutrition intervention on adults with ID from group homes. Although body fat levels were maintained, the study’s hypothesis remained unsupported as no statistically significant changes in percent body fat or BMI were found. The majority of participants did exercise at moderate intensity levels for sufficient periods during the exercise training program. This particular study became the first to assess the effects of a combined intervention on a sample including women with ID as well as adults over thirty from group homes. The small heterogeneous sample reflects the size and great variability that may be found in a variety of community settings featuring adults with ID including group homes. Results concurred with findings from exercise alone interventions, which have also been unable to significantly reduce percent body fat among individuals with ID according to various methods of measurement (Pitetti and Tan, 1991; Pommering et al., 1994; Ozmen et al., 2007). Participants did, however, maintain pretest levels of body fat and did not experience a significant increase in body fat as had been the case in certain exercise only studies (Casey et al., 2010). Indeed, one might argue that there was a clinical if not statistically significant change in body fat level amongst participants. However, findings once again throw into question the potential for exercise to facilitate a reduction in percent body fat in this population as the anticipated changes based on the Macedonio equation (1984) did not take place.

### Table 3

| Participant | Predicted Maximal HR (BPM)# | Lower Limit (BPM) | Upper Limit (BPM) | Mean Week 1 Training HR (BPM) | Mean Week 13 Training HR (BPM) | Mean Week 1-13 Training HR (BPM) | Mean Max HR (%) |
|-------------|-----------------------------|-------------------|------------------|-----------------------------|-------------------------------|----------------------------------|-----------------|
| 1           | 188                         | 113 (60%)         | 151 (80%)        | 122                         | 118                           | 137                              | 73%             |
| 2           | 185                         | 111 (60%)         | 148 (80%)        | 109                         | 120                           | 129                              | 70%             |
| 3           | 172                         | 103 (60%)         | 138 (80%)        | 104                         | 106                           | 111                              | 65%             |
| 4*          | 168                         | 67 (40%)          | 118 (70%)        | 64                          | 87                            | 81                               | 48%             |
| 5*          | 168                         | 67 (40%)          | 118 (70%)        | 86                          | 89                            | 91                               | 54%             |
| 6**         | 177                         | 106 (60%)         | 141 (80%)        | ----                        | ----                          | ----                             | ----            |
| 7           | 172                         | 103 (60%)         | 137 (80%)        | 83                          | 119                           | 111                              | 65%             |
| 8           | 193                         | 116 (60%)         | 155 (80%)        | 156                         | 135                           | 149                              | 77 %            |
| Mean (SD)   | 178(9)                      | 98(19)            | 138(13)          | 103(30)                     | 109(17)                       | 115(24)                          | 64(10)%         |

HR, Heart Rate; BPM, Beats per minute.

*Lower and upper heart rate limits varied based on the presence of type-two diabetes.

** Participant 6 displayed non-compliance with the heart rate protocol.

# Predicted by age-dependent maximal heart rate equation: 208 – (0.7*age) (Tanaka, Monahan, and Seals, 2001).
Although the intervention did not facilitate a statistically significant reduction in body fat, adults with ID demonstrated the capacity to partake in moderate physical activity when given the opportunity (Draheim et al., 2002). The majority of participants’ heart rates remained within target intensity ranges (60-80% of their theoretical maximum heart rates) for a minimum of 15mins, three times per week during aquatic exercise training sessions. The duration of time spent within the target heart rate zone increased as the intervention progressed. One participant with ID was not compliant with the heart rate protocol and declined to wear his
monitor and two more maintained consistently lower heart rates 40-70%. The latter results may have been expected as both had type-two diabetes (>35yrs) (Hornsby and Briggs, 2007) and one also had Down syndrome (Pitetti and Fernhall, 2001). This highlights the additional challenges involved in implementing exercise training programs for adults with ID. Nevertheless, more research needs to examine the potential benefits of participation in moderate to vigorous intensity exercise by adults with ID in light of the benefits shown in younger individuals (Pitetti and Tan, 1991; Pommering et al., 1994).

Researchers hypothesized that the addition of a nutrition intervention would help participants’ preserve lean muscle mass and facilitate a reduction in body fat as has been the case in similarly designed studies on people without ID (Gately et al., 2000) and the only other such study conducted on adults with ID (Croce, 1990). Compulsory educational sessions were introduced as a means to aid participants with food choices as no valid method for assessing dietary intake has been devised for this population thus far (Humphries et al., 2009). However, adults with ID did not experience the reduction of percent body, BMI or weight expected. Therefore, although the study sought to provide individualized attention and adapt nutritional activities for each participant, it is unclear whether the nutritional teaching methods succeeded in satisfying the needs of all individuals. Moreover, food consumption was not directly measured and could not be continually monitored especially when participants left their group home environment. This meant unsupervised participants had the opportunity to engage in unhealthy eating patterns and exceed recommended dietary intake, which research shows is a common occurrence in this population (Bertoli et al., 2006). Group home directors and workers commented on participants’ innovative ways to find extra food and the difficulty of avoiding using food as a reward for good behaviour. Future studies may consider photographing participants’ food consumption during a 24 hour period and combining proxy reporting with interviews and self-reporting as a means to monitor dietary intake (Humphries et al., 2004). Results also seem to support past studies showing that the daily diet of inhabitants in community based residences contains nutrient poor foods and is high in both fat and calories (Prouty and Lakin, 2005). Further research needs to validate dietary guidelines and find practical methods to make healthy eating options more commonplace in group home settings.

Ideally, further investigations should also include one group undertaking a diet plus exercise intervention, another partaking in a diet or exercise alone program and a third acting as a control group in order to assess the effectiveness of specific treatments. Indeed, the lack of a control group, a consistent drawback in disability literature, means that results of the combined intervention must be read cautiously although a recent review noted the ethical concerns raised by randomly withholding treatment for people with disabilities who may benefit from such an intervention (Rimmer et al., 2010). This point is especially pertinent in light of the high prevalence of obesity and related secondary conditions among individuals with ID and more specifically adults with ID who reside in community residences. Nevertheless, with United States policies continuing to favour deinstitutionalization and increasing numbers of individuals with ID moving into small community home settings, more information is needed as to the effectiveness of reduction measures on this population.

Conclusion

To conclude, the aquatic exercise and nutrition intervention proved ineffective at decreasing percent body fat and BMI among adults with ID from group homes. Results agree with findings from exercise alone interventions, but should be read with caution due to the small sample size and absence of a control group. Although findings do suggest that more stringent nutritional guidelines and opportunities to participate in carefully prescribed moderate to vigorous physical activity should be made available for this population.

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References

Altman DG. Ed. Practical statistics for medical research. London, England: Chapman and Hall, 1991 p203-205

Avesani CM, Draibe SA, Kamimura MA, Cendoroglo M, Pedrosa A, Castro ML. Assessment of body composition by dual energy X-ray absorptiometry, skinfold thickness and creatinine kinetics in chronic kidney disease patients. Nephry Dial Transplant, 2004; 19(9): 2289-2295.

Bertoli S, Battezzati A, Merati G, Margonato V, Miggioni M, Testolin G, Veicsteinas A. Nutritional status and dietary patterns in disabled people. Nutr Metab Cardio Dis, 2006; 16: 100-112.

Croce RV. Effects of Exercise and Diet on Body Composition and Cardiovascular Fitness in Adults with Severe Mental Retardation. Educ Train Ment Retard, 1990; 25: 176-187.

Casey AF, Rasmussen R, MacKenzie S, Glenn J. Dual-energy X-ray absorptiometry to measure the influence of a sixteen-week community-based swim training program on body fat in children and adolescents with intellectual disabilities. Arch Phys Med Rehab, 2010; 91(7): 1064-1069.

Draheim CC, Williams DP, McCubbin JA. Prevalence of physical inactivity and recommended physical activity in community-based adults with mental retardation. Mental Retard, 2002; 40: 436-444.

Fernhall B, Pittet K. Limitations to physical work capacity in individuals with mental retardation. Clin Exerc Physio, 2001; 3: 176-185.

Gately PJ, Cooke CB, Buttery RJ, Knight C, Carroll S. The Acute Effects of an 8-Week Diet, Exercise, and Educational Camp Program on Obese Children. Ped Exerc Sci. 2000; 12(4): 413-423.

Havercamp SM, Scandlin D, Roth M. Health disparities among adults with developmental disabilities, adults with other disabilities, and adults not reporting disability in North Carolina. Public Health Reports, 2004; 119: 418-426.

Hornsby WG, Briggs P. Aquatic therapy/exercise in management and prevention of diabetes mellitus. Aqua Ther J, 2007; 9(1): 9-13.

Humphries K, Traci MA, Seekins T. A preliminary assessment of the nutrition food-system environment of adults with intellectual disabilities living in supported arrangements in the community. Ecology of Food and Nutrition. Ecol Food Nut., 2004; 43: 517-532.

Humphries K, Traci MA, Seekins T. Nutrition and Adults with Intellectual or Developmental Disabilities: Systematic Literature Review Results. Intell Dev Disabil, 2009; 47(3): 163-185.

Jackson SL. Research methods and statistics: A critical thinking approach. 3rd Ed Cengage Learning, Belmont, California, 2008, p 242-245.

Krahn GL, Hammond L, Turner A. A cascade of disparities: Health and health care access for people with intellectual disabilities. Ment Retard Devel Disabil, 2006; 12(1): 70-82

Lazzar S, Bedogni G, Agosti, F, De Col A, Mornati D, Sartorio A. (2008). Comparison of dual-energy X-ray absorptiometry, air displacement plethysmography and bioelectrical impedance analysis for the assessment of body composition in severely obese Caucasian children and adolescents. Br J Nutr. 2008; 100: 918-924.

Macedonio M. Nutritional management of the obese individual. In J. Storlid and H.A. Jordan (Eds). Nutrition and exercise in obesity management. Spectrum publications: New York; 1984.
Medlen JG. The Down syndrome Nutrition Handbook: A Guide to Promoting Healthy Lifestyles. Phronesis Publishing: Portland, OR; 2002.

Ordoñez RJ, Rosety M, Rosety-Rodriquez M. Influence of 12-week exercise training on fat mass percentage in adolescents with Down syndrome. Med Sci Monit, 2006; 12(10): 416-419.

Pitetti KH, Tan DM. Effects of a minimally supervised exercise program for mentally retarded adults. Med Sci Sports Exerc, 1991; 23(5): 594-601.

Pommering TL, Brose JA, Randolph E, Murray TF, Purdy RW Cadamagnani PE. Effects of an aerobic exercise program on community-based adults with mental retardation. Ment Retard, 1994; 32(3): 218-226.

Prior BM, Cureton KJ, Modlesky CM, Evans EM, Sloniger MA, Saunders M. In vivo validation of whole body composition estimates from dual-energy X-ray absorptiometry. J Appl Physiol. 1997 83(2): 623-630.

Prouty RW, Lakin KC. Residential services for persons with developmental disabilities: Status and trends through 2005. Minneapolis: University of Minnesota Research and Training Center on Community Living.

Ozmen T, Yidirim NU, Yuktasir B, Beets MW. Effects of school-based cardiovascular-fitness training in children with mental retardation. Pediatr Exerc Sci. 2007; 19: 171-178.

Rimmer JH, Chen MD, McCubbin JA, Drum C, Peterson J. Exercise intervention research on persons with disabilities: what we know and where we need to go. Am J Phys Med Rehabil, 2010; 89: 249-63.

Rimmer JH, Yamaki K. Obesity and intellectual disability. Ment Retard Devl Disabil, 2006; 12: 22-27.

Ross R, Janssen I. Physical activity, total and regional obesity: Dose-response considerations. Med Sci Sports Exerc, 2001; 33(6); S521-S527.

Starr JM, Mardesen L. Characterisation of user-defined health status in older adults with intellectual disabilities. J Intell Disabil Res, 2008; 52(6): 483-489.

Tanaka, K, Monahan, K.D., and Seals, D.R. (2001). Age-predicted maximal heart rate revisited. Journal of the American College of Cardiology, 37(1), 153-156.

Tepas III JJ, Sharmab R, Leapharta CL, Celsoc BG, Piepera P, Esquivia-Leea V. Timing of surgical intervention in necrotizing enterocolitis can be determined by trajectory of metabolic derangement. J Ped Surg, 2010; 45: 310–314.

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