Aquatic Therapy to Address Obesity and Deconditioning in Pediatrics

Kathleen (Kiki) Dickinson, PT, PAqI

medbridge

Acknowledgments

- Thanks to Mia Schmidtke, DPT, PT, for her contributions to this presentation, which included her extensive and thorough review of the research on the topics in this course and her contributions to the PowerPoint slides
- Thanks to all the families, students, and children who allowed me to film them and share the footage with the audience so that therapists can continue to progress in their clinical skills

Learning Objectives

- Apply evidence-based research on the incidence, causes, and impact of obesity and deconditioning in children and adolescents, with a focus on those with disabilities
- Evaluate the benefits of high-intensity interval training (HIIT) for addressing obesity and deconditioning in children and adolescents with disabilities
- Analyze the impact of aquatic HIIT and related techniques on land-based therapy outcomes for children and adolescents
- Develop aquatic treatment strategies to improve strength, balance, coordination, and gross motor skills in children and adolescents with obesity and deconditioning
- Apply clinical decision-making to appropriately progress or regress aquatic therapy sessions for optimal treatment intensity and effectiveness

Obesity and Deconditioning in Children

- According to the World Health Organization (WHO)
  - In 2024, more than 35 million children younger than 5 years were overweight
  - In 2022, more than 390 million children ages 5–19 were overweight, and, of these, 160 million were living with obesity

World Health Organization, 2020

Physical Inactivity in Children and Adolescents

- In 2020, 16.2% of youths aged 10–17 were living with obesity, with another 15.5% overweight, according to the National Survey of Children's Health
- In 2020, 19.7% of youths aged 2–19 were classified as having obesity
  - Black and Latino boys were more likely to have obesity

State of obesity 2022: Better Policies for a healthier America 2023

Obesity Demographics

- Levels and rates of obesity vary drastically between groups
  - Rural vs. urban
    - Rural areas have higher rates of obesity
  - Income and education
    - Higher rates of obesity are seen among lower-income households and those without a college degree
  - Race and ethnicity
    - The highest prevalence of obesity is found among Black Americans, followed by Latino, White, and Asian Americans

State of obesity 2022: Better Policies for a healthier America 2023

Overweight and Obese Children and Adolescents

- Not meeting recommended physical activity guidelines for their age
- Results from an “imbalance of energy intake (diet) and energy expenditure (physical activity)”
- Multifactorial
  - Genetics
  - Psychosocial factors
  - Environmental factors
  - Socioeconomic status

World Health Organization, 2020

Physical Activity Guidelines: Age <1

- In a 25-hour span, they should spend at least 30 minutes engaged in active movement
  - Prone (tummy time)
  - Reaching and interacting with others
- No sedentary screen time
- Good-quality sleep
  - 14–17 hours for 0–3 months of age
  - 12–16 hours for 4–11 months of age

World Health Organization, 2025

Physical Activity Guidelines: Ages 1–2

- In a 25-hour span, they should spend at least 180 minutes engaged in a variety of physical activities
  - Any intensity: crawling, walking, or standing
  - Reaching and playing with toys
  - Interacting with others
- Sedentary screen time
  - None for children 1 year of age
  - No more than 60 minutes for children 2 years of age
- Good-quality sleep for 11–14 hours

World Health Organization, 2025

Physical Activity Guidelines: Age 3–4

- In a 25-hour span, they should spend at least 180 minutes doing a variety of physical activities
  - At least 60 minutes should be at moderate- to vigorous-intensity physical activity
  - Running, walking, sports, and interacting with peers
- Sedentary screen time: no more than 60 minutes
- Good-quality sleep for 10–13 hours

World Health Organization, 2025

Physical Activity Guidelines: Age 5+

- 60 minutes of moderate-to vigorous-intensity aerobic activities per day across the week; most should be aerobic physical activity
- At least three days of the week should include activities to strengthen bones and muscles
- Limit the amount of time spent being sedentary, particularly recreational screen time

World Health Organization, 2025

Chapter 1

Pediatric Obesity and Deconditioning Evidence-Based Research

Obesity in Children With Disabilities

- Adolescents with intellectual disabilities are at higher risk of developing obesity or being overweight compared with typically developing adolescents[1]
- Adolescents with Down syndrome are 2–3 times more likely to be obese[2]
- Adolescents with physical and/or cognitive disabilities are more likely to be obese[3]
- Children with disabilities are 306 times more likely to be overweight or obese compared with nondisabled children[4]

1. Maïano et al., 2016
2. Rimmer et al., 2010
3. Rimmer et al., 2011
4. Neter et al., 2011

Obesity in Children With Disabilities (cont.)

> **Obese youth with intellectual and developmental disabilities (IDD) have a high number of obesity-related secondary conditions predisposing them to greater health problems as they transition to adulthood**

— Rimmer et al., 2010

Obesity in Children With Disabilities (cont.)

- Secondary conditions
  - High blood pressure and cholesterol
  - Diabetes
  - Depression, low self-esteem, and fatigue
  - Liver and gallbladder problems
  - Preoccupation with weight, early maturation
  - Pressure sores

Rimmer et al., 2010

Obesity in Children With Disabilities (cont.)

- At age 3 years, there are already noticeable differences in the prevalence of being overweight for children with and without developmental delays
- By age 5 years, this difference is even greater
- This may be the result of greater challenges for children with disabilities in maintaining the recommended physical activity level, recommended diet, and overall attention to and awareness of obesity

Reinehr et al., 2010

Causes of Obesity in Children

- Social determinants of health play a big role
  - Children living in medically underserved communities
  - Lower income and food insecurity
  - Health and racial inequalities
- COVID-19 pandemic
  - Increased BMI values following COVID
  - Four times as many 4- to 5-year-olds in a federally qualified health center were classified as having obesity following the pandemic, compared with a similar timeframe prepandemic
    - Transitioned from a healthy weight to having obesity

Moriarty et al., 2025

Physical Activity Guidelines: Age 5–17 Living With a Disability

- 60 minutes of moderate-to vigorous-intensity aerobic activities throughout the day across the week, most being aerobic
- At least three days of the week should include activities to strengthen bones and muscles
- Limit the amount of time spent being sedentary, especially screen time
- Same guidelines as for a typically developing child

World Health Organization, 2025

Promote Physical Activity

- “Exercise, diet, awareness, and attention to obesity, social participation are relevant areas of risk factors for obesity and overweight children and adolescents”
- Treatments should be tailored toward individuals’ abilities and interests and should account for their personal physical, cognitive, and/or sensory impairments to achieve optimal results

Reinehr et al., 2010

Chapter Summary

- Children and adolescents with physical, mental, or cognitive disabilities are at greater risk of being overweight or obese
- Any activity is more beneficial than nothing, but the more the better!
  - Encouraging children and adolescents with disabilities to be physically active is vital to their overall health
- Social determinants of health, such as income, race, and healthcare access, significantly contribute to pediatric obesity
- WHO's physical activity guidelines vary by age and ability but consistently emphasize regular movement

Chapter 2

Positive Impact of HIIT and Other Aquatic Techniques for Childhood Obesity and Deconditioning

High-Intensity Interval Training (HIIT)

Children participating in HIIT can experience improvements in

- Cardiovascular health[1–3]
- Body mass index (BMI)[2]
- Reduced total cholesterol and LDL[2]
- Mental health and cognitive performance[3]
- Body composition and blood pressure[1,2,3]

1. Eddolls et al., 2017
2. Lopes et al., 2021
3. Poon et al., 2023

Aquatic HIIT

- A study of the “high-intensity interval training program in the aquatic environment in obese teens” gave the following guidelines for aquatic HIIT
- These parameters were found to be effective in reducing cardiometabolic risk factors

Lopes et al., 2021

Aquatic HIIT Parameters

- Use maximum heart rate (maxHR) to determine intensity
  - 80%–95% maxHR
  - “Hard to very hard” on the RPE scale
- Rest times should still be active
  - Lower-intensity HR
- On-time intervals are shorter than active rest times
  - 1:2 ratio, 1:3 ratio, etc.

RPE Scale

Rating	Descriptor
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard

Lopes et al., 2021

Aquatic HIIT Example Program

- Example
  - 12-week program, three times a week
  - Two sets of 4–8 repetitions for 30 seconds at maxHR
  - 60 seconds of active rest
  - **Exercises**
    - **Stationary running, frontal kicks, and ski jumps**

Lopes et al., 2021

Stationary Running, Frontal Kicks, and Ski Jumps

Stationary Running, Frontal Kicks, and Ski Jumps (Underwater View: Shallow and Deep)

Aquatic HIIT

- A study conducted of “high-intensity interval training in children and adolescents with special education needs: a systematic review and narrative synthesis” gave the following guidelines for aquatic-based HIIT
- **Determined that HIIT may improve**
  - **Mental health and cognitive performance**
  - **Body composition, cardiometabolic risk factors, and physical fitness**

Poon et al., 2023

Aquatic HIIT Example Program 2

- HIIT for children with special education needs: systematic review
  - 2–15-week program, two to four times a week
  - MaxHR at 80%
  - 2 sets of 4–8 repetitions for 30 seconds at maxHR
  - 60 seconds of active rest

Poon et al., 2023

Aquatic HIIT Example Program 2 (cont.)

- **Exercises**
  - Sprinting, functional activity, running, circuit training, low-complexity exercise, aerobic and anaerobic exercise (e.g., running and jumping jacks), or a combination of running, strength training, and plyometrics

Poon et al., 2023

Sprinting With Functional Activity

Functional Activity
Carrying a Tray

Running

Low Complexity

Aerobic

Combination of Running/Strength Training/Plyometrics

Combination of Running/Strength Training/Plyometrics (Underwater View)

Positive Benefits for Children With Special Education Needs

- A study concluded **HIIT is a viable strategy to implement for children with special education needs, based on the positive benefits** found following a HIIT training program
- Including
  - **Improved physical fitness**
  - **Improved cardiometabolic risk biomarkers**
  - **Improved mental health and cognitive performance**

Poon et al., 2023

Chapter Summary

- HIIT is a beneficial and effective training method to induce health benefits for children and adolescents with disabilities, including
  - **Improved physical and mental health**
  - **Improved cardiovascular health**
  - **Lower BMI**
- Aquatic HIIT is especially effective and safe for children with disabilities
- Effective aquatic HIIT parameters: 80%–95% of maximum heart rate, with active rest periods (1:2 or 1:3 ratios)
- Research supports aquatic HIIT's benefits in physical fitness, body composition, and cognitive-emotional development
- Programs can use simple, functional aquatic exercises like running, kicks, and plyometrics

Chapter 3

Aquatic Treatment Strategies and Optimal Treatment Intensity

Aquatic Exercise Applications for Obesity

- **Offers a protective environment due to buoyancy**
  - **Minimizes risk of joint injury**
- Helps preserve and protect the health and longevity of participants
- Aquatic programs should be
  - In chest-deep water for aerobic exercise and "alternated with balance and coordination drills"

Becker, 2009

Aquatic Exercise Applications for Obesity (cont.)

- **Allows for vigorous exercise due to diminished body weight in water**
  - "On dry land, the ability to achieve an aerobic exercise level for sufficient time to produce a conditioning effect may be difficult in this population, and a program that begins in water and moves to land as strength, endurance, and tolerance build may be a more effective method of achieving both conditioning and weight loss."

Becker, 2009

HIIT in Aquatic Environment

- Effective in reducing the risks related to cardiac and metabolic factors for children diagnosed with obesity[1,2]
- Improves health benefits and overall fitness[1,2]
- Improves aerobic capacity in ambulant adolescents with cerebral palsy[3]
  - When adherence to the program is maintained

1. Lopes et al., 2021
2. Moreno et al., 2022
3. Depiazzi et al., 2020

Effects of Aquatic and Land High-Intensity Interval Training on Selected Bio and Physiological Variables Among Obese Adolescents

Liao et al., 2024

Aquatic vs. Land HIIT

- Specifically in obese adolescents (ages 10–18, with a BMI of 24–35 kg/m^2)
- **Four weeks, three times per week, for 1 hour each session**
  - 20 min warmup, 30 min HIIT, with a 10 min cooldown
- Looked at body composition, blood pressure, lipid metabolism, anthropometry, and physical function pre- and post-intervention

Liao et al., 2024

Aquatic vs. Land HIIT (cont.)

- Warmup
  - Land dynamic stretching and 10 minutes of aquatic exercises
  - **Warmup heart rate kept between 50%–55% of HRmax**
  - The land group had a full warmup on land
  - The aquatic group had 10 min on land and 10 min in the water

Liao et al., 2024

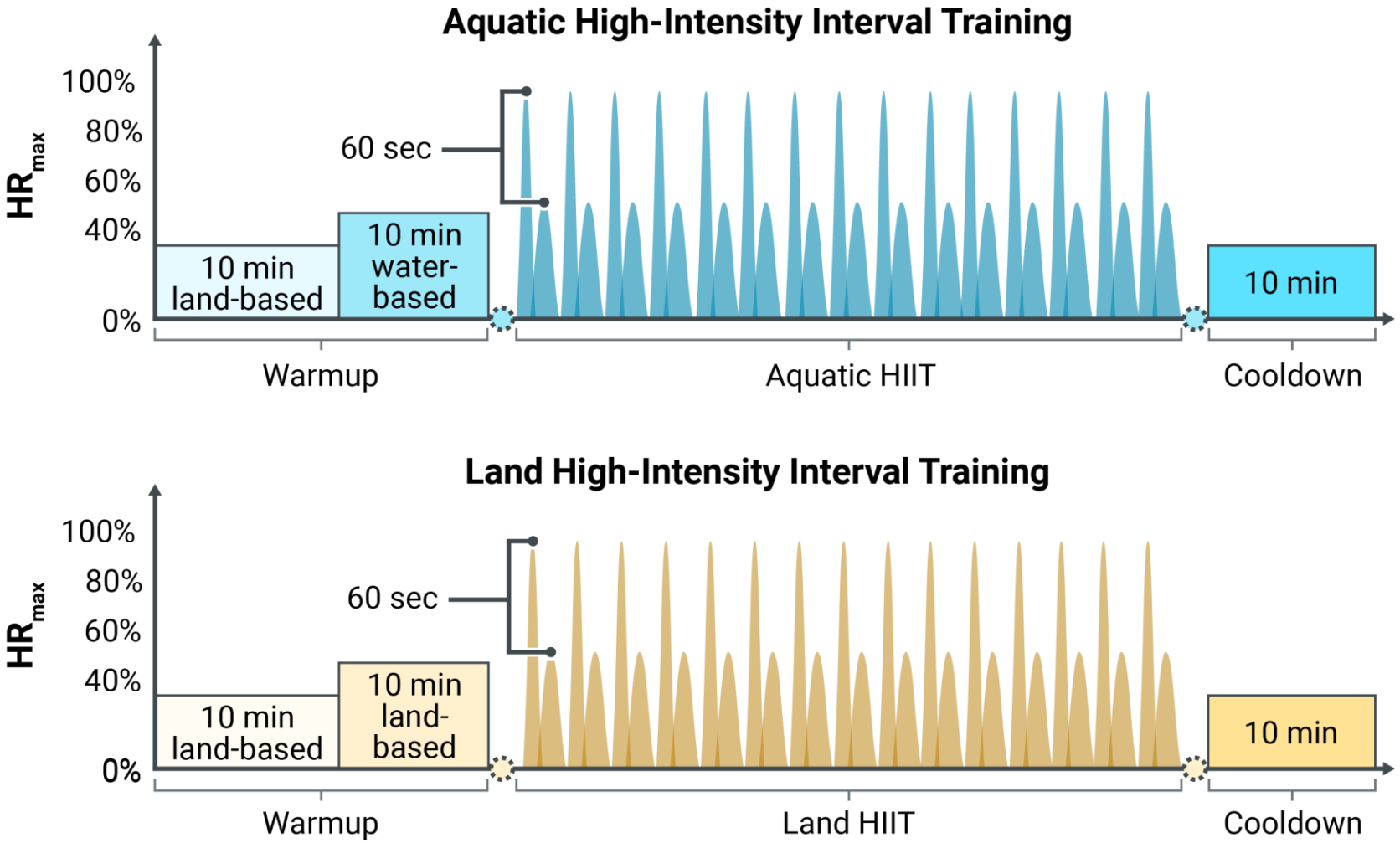
HIIT Exercises

- Movements included during land and aquatic HIIT
  - **Rocking horse**
  - **Squat jumps**
  - **Jumping jacks**
  - **Cross-country ski**
  - **High knees**
- Recovery movements included jogging and slow walking in the water
- Cooldown
  - Static land stretching for 10 minutes at the end of the session

Liao et al., 2024

Examples of Some of the HIIT Exercises

Intervention Protocol



Liao et al., 2024

Intervention Protocol (cont.)

- HIIT for 60 seconds followed by 60-second recovery period
- MaxHR of 80%–90% for land HIIT
  - Maintained at least 50% MaxHR for active recovery
- RPE of 17–18 for the aquatic HIIT
  - RPE of 11–12 for the active recovery

Liao et al., 2024

Conclusions of the Study

- Land and aquatic
  - **Significantly reduced “body mass BMI, body fat rate, waist circumference, hip circumference, and body water content”**
  - **Significantly increased lean body mass**
  - **Decreased systolic and diastolic BP** while increasing vital capacity and total energy consumption

Liao et al., 2024

Conclusions of the Study (cont.)

- Aquatic
  - "Aquatic HIIT may be effective in improving the body composition, physical function, blood pressure, and LDL-C of overweight and obese adolescents"
  - **Significantly better improvements in "lean body mass, waist circumference, waist-to-hip ratio, vital capacity, and total energy consumption" compared with the land group**

Liao et al., 2024

Overall Conclusion of Study

- **Aquatic HIIT may be the better option when wanting to control weight levels in obese adolescents**
- Both land and aquatic HIIT are beneficial for overweight and obese adolescents
- **Short-term (four-week) HIIT can be a viable option for adolescents who are overweight or obese**
- “Aquatic HIIT may be superior to the land HIIT in weight control among the obese adolescents”

Liao et al., 2024

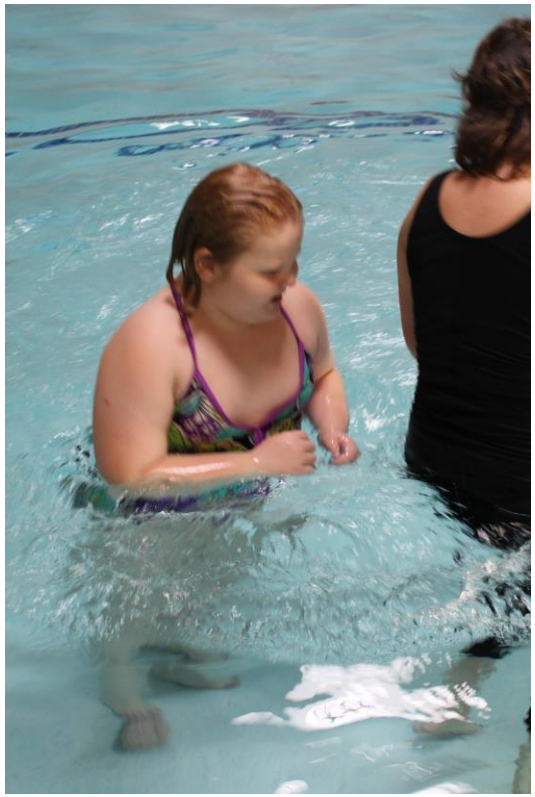
Chapter Summary

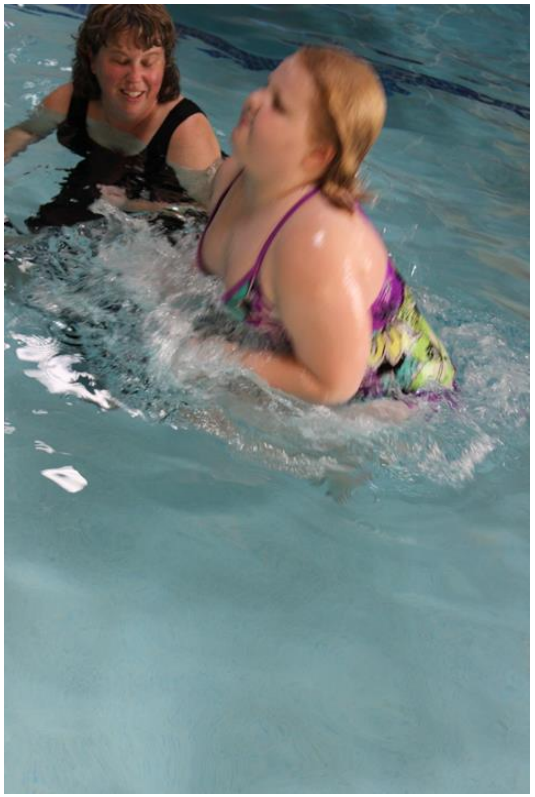
- **Aquatic HIIT can be used as an effective treatment**
  - Reduces BMI
  - Increases total energy consumption
  - Leads to better overall health and well-being of children and adolescents with disabilities
- Aquatic environments offer **joint offloading, safety, and tolerance** for higher-intensity movement
- HIIT in water leads to improved aerobic capacity, especially in children with cerebral palsy and other physical limitations

Chapter 4

Clinical Decision-Making for Progression and Regression in Aquatic Pediatric Therapy

Strategies for Children/Adolescents With Obesity and Deconditioning





Strategies for Children/Adolescents With Obesity and Deconditioning (cont.)

Weighted Ball Overhead

Light Jog in Chest-Deep Water

Plyometrics

Throwing Weighted Ball

Jumps With a Pool Step

Traveling Over a Pool Step

Agility Ladder

Deep Water Work (HIIT)

Facilitated Resisted Blowing

Tall Kneel on a Flotation Mat With UE Dynamic Activity

Modified Plank With LE Alternating Lifts

Rocking Horse, Squats, and High Knees (Circuit Training) With and Without Aquatic Paddles

Treatment and Control of Obesity in Children

- Physical Therapy as Treatment for Childhood Obesity in Primary Healthcare: Clinical Recommendation From AXXON (Belgian Physical Therapy Association)

Hansen et al., 2016

Treatment and Control of Obesity in Children (cont.)

- Physical therapists (PT) are often underrecognized and underused in the prevention and treatment of obesity
- PTs should monitor youths with obesity and evaluate the need for (and safety of) increasing duration and intensity of physical activity

Treatment and Control of Obesity in Children (cont.)

PTs should determine the appropriate duration and intensity of physical activity based on

- Patient presentation, medical precautions, and orthopedic conditions
- BMI, body composition
- Prior activity level, endurance level, and safety of exercise
- Other barriers (mental, physical, environmental, etc.)

Treatment and Control of Obesity in Children (cont.)

- It is often assumed that increased physical activity is medically safe in children/adolescents with obesity
- Potential role of exercise-limiting factors to be monitored
  - Orthopedic issues
  - Asthma
  - Exercise hypertension
  - Insulin resistance
  - Diabetes

Treatment and Control of Obesity in Children (cont.)

- The physical therapist is **underrecognized and underused** in the prevention and treatment of obesity
- Physical therapists should evaluate and monitor obese children/adolescents who plan to increase their level of physical activity, secondary to their knowledge of
  - Pathology
  - Pharmacotherapy
  - Exercise physiology

Hansen et al., 2016

Treatment and Control of Obesity in Children (cont.)

- A systematic literature review was conducted to determine reliable, valid, and feasible tests (group consensus)
- The following items and characteristics should be assessed before an exercise intervention
  - Medical safety
  - Physical activity
  - Weight status
  - Body composition
  - Physical fitness

Hansen et al., 2016

Maximizing Adherence and Continued Elevated Physical Activity

- Address internal and external barriers to exercise
- Refer to a psychologist as needed
- Create a “fun and stimulating” environment
- Set realistic goals
- Provide positive attention and compliments
- Avoid negative attention

Hansen et al., 2016

Maximizing Adherence and Continued Elevated Physical Activity (cont.)

- Exercises should be fun, varied, and not too difficult
- Group exercise with peers greatly enhances motivation
- Parents and/or physical therapists should participate in the exercises
- Cooperation/support of parents/guardians is important
  - Key role models for a healthy lifestyle (OT!)
- Provide regular feedback on improvements in health parameters, especially weight

Hansen et al., 2016

Chapter Summary

- PTs/OTs should play an active role in addressing childhood obesity, especially in children with disabilities
- **PTs/OTs should determine the appropriate duration and intensity of physical activity**
- More research is needed to determine the appropriate duration and intensity for this population
- It is challenging for research protocols to document intensity parameters
- Aquatic strategies can enhance **strength, balance, coordination, and gross motor function**
- Use of weighted balls, plyometrics, agility drills, and flotation tools helps create varied and motivating sessions
- Incorporating structured, dynamic exercises (like HIIT circuits) promotes cardiovascular and muscular improvements

Course Summary

- Children and adolescents with disabilities are at a disadvantage compared with typically developing youth when it comes to maintaining a healthy weight
  - They are at greater risk for secondary complications due to excessive weight
  - They are at higher risk for being overweight or obese due to multiple factors, including dietary needs, being less active than typically developing kids, and having less awareness of body weight
- HIIT is beneficial for helping control weight and increasing physical activity for children and adolescents with disabilities
  - Decreases in BMI, improved body composition, and overall improvements in mental health were found following HIIT programs

Course Summary (cont.)

- Aquatic HIIT can be a beneficial and impactful treatment for children and adolescents when used correctly
  - **Programs must be able to get high intensity in the aquatic environment**
  - If an aquatic HIIT program is followed, benefits may be seen in children's and adolescents' mental health, cognition, and overall ability to participate in physical activity outside of the pool
- Therapists are often underrecognized and underused in the prevention and treatment of obesity
- An active lifestyle decreases the risk of obesity
- Physical inactivity is a leading risk factor for morbidity and mortality
- More research is needed to determine the appropriate duration and intensity for this population

Bibliography

Medbridge

Aquatic Therapy to Address Obesity and Deconditioning in Pediatrics

Kathleen (Kiki) Dickinson, PT, PAqI

Depiazzi, J., Smith, N., Gibson, N., Wilson, A., Langdon, K., & Hill, K. (2020). Aquatic high intensity interval training to improve aerobic capacity is feasible in adolescents with cerebral palsy: Pilot randomised controlled trial. *Clinical Rehabilitation, 35*(2), 222–231. https://doi.org/10.1177/0269215520956499

Eddolls, W. T., McNarry, M. A., Stratton, G., Winn, C. O., & Mackintosh, K. A. (2017). High-intensity interval training interventions in children and adolescents: A systematic review. *Sports Medicine, 47*(11), 2363–2374. https://doi.org/10.1007/s40279-017-0753-8

Geigle, P. R., Ogonowska-Slodownik, A., Smith, J. E., James, K., & Scott, W. H. (2022, February 23). Metabolic and cardiopulmonary impact of aquatic exercise and nutritional guidance for four individuals with chronic motor incomplete spinal cord injury: A case series. *Physiotherapy Theory and Practice, 23*, 1–10.

Hansen, K., et al. (2016). *Physical Therapy, 96*(6), 850–863.

Liao, T., Zheng, C., Xue, J., & Wang, Y. (2024). Effects of aquatic and land high-intensity interval trainings on selected bio- and physiological variables among obese adolescents. *Frontiers in Endocrinology, 15*. https://doi.org/10.3389/fendo.2024.1381925

Lopes, M. de F. A., Bento, P. C. B., & Leite, N. (2021). High intensity interval training program in the aquatic environment (HIITAQ) in obese teens. *Journal of Physical Education, 32*. https://doi.org/10.4025/jphyseduc.v32i1.3238

Maïano, C., Moullec, G., Morin, A. J. S., & Hue, O. (2016, May 12). Prevalence of overweight and obesity among children and adolescents with intellectual disabilities: A systematic review and meta-analysis. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*. https://pubmed.ncbi.nlm.nih.gov/27171466/

Moreno, J. E., De León, L. G., Ortiz-Rodríguez, B., & Candia-Luján, R. (2022). High intensity interval training (HIIT) in an aquatic environment: A systematic review. *Science & Sports, 37*(5–6), 383–392. https://doi.org/10.1016/j.scispo.2021.12.004

Moriarty, M. T., Law, W. R., Nadolski, J., & Hockenberry, L. (2025). Changes in pediatric obesity rates before and during the COVID pandemic in a Federally Qualified Health Center. *Preventive Medicine Reports, 25*, 103044.

Naczk, A., Gajewska, E., & Naczk, M. (2021). Effectiveness of swimming program in adolescents with Down syndrome. *International Journal of Environmental Research and Public Health, 18*, 7441.

Neter, J. E., Schokker, D. F., de Jong, E., Renders, C. M., Seidell, J. C., & Visscher, T. L. S. (2011). The prevalence of overweight and obesity and its determinants in children with and without disabilities. *The Journal of Pediatrics, 158*(5), 735–739. https://doi.org/10.1016/j.jpeds.2010.10.039

Ozdol, Y., Onen, M. E., Erzeybek, M. S., Sanli, G., & Pinar, S. (2018, September). *The Borg rating of perceived exertion (RPE) scale: Choosing exercise cadence on the outdoor stepper for various exercise intensity*. https://www.researchgate.net/publication/320143143_The_Borg_Rating_of_Perceived_Exertion_RPE_scale

Poon, E. T.-C., Wongpipit, W., Sun, F., Tse, A. C.-Y., & Sit, C. H.-P. (2023). High-intensity interval training in children and adolescents with special educational needs: A systematic review and narrative synthesis. *International Journal of Behavioral Nutrition and Physical Activity, 20*(1). https://doi.org/10.1186/s12966-023-01421-5

Reinehr, T., Dobe, M., Winkel, K., Schaefer, A., & Hoffmann, D. (2010). Obesity in disabled children and adolescents. *Deutsches Ärzteblatt International*. https://doi.org/10.3238/arztebl.2010.0268

Rimmer, J. H., Yamaki, K., Lowry, B. M., Wang, E., & Vogel, L. C. (2010). Obesity and obesity-related secondary conditions in adolescents with intellectual/developmental disabilities. *Journal of Intellectual Disability Research, 54*(9), 787–794. https://doi.org/10.1111/j.1365-2788.2010.01305.x

Rimmer, J. H., Yamaki, K., Davis, B. M., Wang, E., & Vogel, L. C. (2011). Obesity and overweight prevalence among adolescents with disabilities. *Preventing Chronic Disease, 8*(2).

Stierman, B., Afful, J., Carroll, M. D., Chen, T. C., Davy, O., Fink, S., et al. (2021). National Health and Nutrition Examination Survey 2017–March 2020 prepandemic data files—Development of files and prevalence estimates for selected health outcomes. *National Health Statistics Reports, 158*. National Center for Health Statistics.

World Health Organization. (2020, November 25). *WHO guidelines on physical activity and sedentary behaviour*. https://www.who.int/publications/i/item/9789240015128

World Health Organization. (2025, May 7). *Obesity and overweight*. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight