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Perspective

Health benefits of interval walking training

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Abstract

Interval walking training (IWT) is a free-living training intervention involving alternating fast and slow walking cycles. IWT is efficacious in improving physical fitness and muscle strength, and reducing factors associated with lifestyle-related diseases. In individuals with type 2 diabetes, IWT improves glycemic control directly through enhanced glucose effectiveness, challenging conventional views on mechanisms behind training-induced improvements in glycemic control. Whereas adherence to IWT in short-term studies is high, ensuring long-term adherence remains a challenge, particularly in populations with chronic diseases and/or overweight/obesity. Long-term studies in real-world settings are imperative to ascertain the widespread effectiveness of IWT and elucidate its impact on hard endpoints.

Key words: exercise, interval training, interval walking, health benefits, adherence, type 2 diabetes, lifestyle intervention

Introduction

As the world's elderly population continues to grow, the need to prescribe exercise that can be performed by older, fragile individuals is increasingly needed. Interval walking training (IWT) was originally developed in Japan as a training intervention for older individuals (Nose et al. 2009). As originally described, an IWT session consisted of no less than five repeated cycles of fast and slow walking, 3 min each, at a speed equal to or above 70% and around 40% of the individual physical fitness level (VO_{2peak}), respectively (Nemoto et al. 2007). To ensure correct walking intensities in free-living training conditions, a waist-worn device (named "JD Mate") assessed intensity by accelerometry and barometry, giving auditory signals that helped the user understand whether the training intensity was correct and when to alternate between fast and slow walking intervals. Training data were subsequently uploaded to a server, allowing feedback to the user if needed. From this, it follows that IWT is an individually adapted training modality with minimal requirements for equipment and supervision, which theoretically can be maintained as long-term, free-living exercise at home.

Compared to other interval training regimes like, for example, high-intensity interval training (MacInnis and Gibala 2017), the walking nature of IWT implies that it is of lower absolute intensity. As such, IWT is typically fully aerobic, as indicated by only moderate increases in lactate levels during IWT sessions (Karstoft et al. 2014*b*; Jakobsen et al. 2016). This means that IWT is feasible for most individuals, including older individuals with lower physical fitness levels and different kinds of noncommunicable diseases. Furthermore, IWT has been tested in various populations and its potential health benefits have in different combinations been compared to no exercise, standard of care, and continuous walking training (CWT). In this perspective paper, we will describe the health benefits of IWT, both in healthy and various diseased populations. Moreover, we will discuss some of the challenges associated with IWT, highlighting unresolved issues that need addressing before IWT can be implemented as a general real-world intervention.

Health benefits in healthy individuals

The effects of IWT on physical fitness, muscle strength, and blood pressure were initially investigated in a controlled trial with middle- and older-aged (mean age 63 years) individuals completing one of three interventions: no exercise, moderate-intensity CWT, and IWT (Nemoto et al. 2007). After 5-months intervention (60 min/d, 4 days/week), on average, IWT increased VO_{2peak} by 10% and knee extension and flexion forces by 13% and 17%, respectively, and reduced systolic and diastolic pressures by 9 and 5 mmHg, respectively. In contrast, CWT resulted in minimal changes in these variables that were not different to changes seen in the nonexercising group. In a subset of the training individuals, physical activity was recorded using the JD Mate, indicating that the training effort (number of training days and overall training-associated energy expenditure) was not different between the IWT and CWT groups.

Next, the effects of IWT were assessed in a 4-month, single-arm intervention study also including middle- and older-aged (mean age 65 years) individuals (Morikawa et al. 2011). Changes in lifestyle-related disease (LSD) scores were calculated based on changes in blood pressure, blood glucose, triglycerides, high-density lipoprotein cholesterol, and body mass index (BMI), as specified in the Japanese government's health care guidelines (Health Insurance Bureau, Ministry of Health, Labour, and Welfare, Japan 2007). Ninety-five percent of the enrolled participants completed the IWT program (60 min/day, 4 days/week), and the LSD score decreased on average by 20%. Except for blood lipids, all the individual factors included in the LSD score calculation improved, with the contribution to the overall decrease being greater in the order of improvements in blood pressure, blood glucose, and BMI. Furthermore, a 15% improvement in VO_{2peak} was seen with the IWT intervention, and greater improvements in VO_{2peak} were associated with greater reductions in LSD score.

Finally, long-term effects of IWT were evaluated in another single-arm intervention study including middle- and older-aged (mean age 65 years) individuals who were prescribed 22 months of IWT (Masuki et al. 2015). In this study, overall improvements in LSD score were confirmed, with higher adherence rates resulting in greater improvements. Similarly, VO_{2peak} was also improved to a larger extent in individuals who were more adherent to the intervention.

Overall, these studies demonstrate that IWT is feasible in middle- and older-aged but otherwise healthy individuals, and that IWT more greatly improves physical fitness and muscle strength compared to CWT. Moreover, IWT improves risk factors for lifestyle-related diseases, both in shorter and in longer term interventions.

Health benefits in diseased populations

In addition to healthy populations, IWT has been tested in populations with different metabolic and nonmetabolic diseases. Here, an overview of the outcomes will be given.

Metabolic diseases

In 2014, we published a randomized controlled trial investigating the effects of 4 months of IWT versus mean-intensity and time-duration matched CWT versus no exercise in individuals with type 2 diabetes (T2D) (Karstoft et al. 2013). Results indicated that IWT was a feasible training modality in this population and that IWT was superior to both CWT and no exercise for improving physical fitness, body composition, and measures of free-living blood glucose levels assessed via continuous glucose monitoring. Additional experiments in the same study using hyperglycemic clamps and glucose tracers showed that the IWT-induced improvements in glycemic control were dependent on improved peripheral glucose disposal (Karstoft et al. 2014*a*). When using a hyperglycemic clamp, an increase in glucose disposal is theoretically due to improvements in insulin sensitivity and/or glucose effectiveness. Therefore, to further assess which of these were responsible for the improvements in glycemic control with IWT, a subsequent study was performed using a two-step hyperglycemic, pancreatic clamp setup with low (averaging normal fasting) and high (hyperinsulinemic) insulin levels (Karstoft et al. 2017*a*). This study indicated that glucose effectiveness but not insulin sensitivity was improved with IWT. Moreover, changes in glucose effectiveness were associated with changes in measures of glycemic control. As such, these data challenge the classical dogma that training-induced improvements in glycemic control are dependent on improvements in insulin sensitivity alone, and that glucose effectiveness plays an important role. Importantly, it must be stated that no overall changes in body composition were seen in this study (Karstoft et al. 2017*c*), prompting us to speculate that direct effects of exercise training are mediated via improvements in glucose effectiveness, whereas secondary effects are mediated via improvements in insulin sensitivity due to improvements in body composition. The successful matching between the IWT and CWT groups in the abovementioned studies makes the superiority of IWT interesting. Potential explanations for the differential effects on body composition include greater excess postexercise oxygen consumption and nonexercise activity thermogenesis of IWT, whereas resting metabolic rate does not seem to be affected (Karstoft et al. 2016, 2017*b*). The body composition-independent superiority of IWT versus CWT on glycemic control is not readily explained, but it may be speculated that the higher peak intensity of IWT leads to greater glucose disposition in skeletal muscle via increased enzymatic activity and/or glucose transportation (Karstoft et al. 2017*a*).

These above-described results on glycemic control in individuals with T2D have been backed up in studies of both longer (Christensen et al. 2019) and shorter (Karstoft et al. 2014*b*; Jakobsen et al. 2016) duration. However, while all these studies indicate superior effects of IWT on glycemic control compared to CWT and/or no exercise, it must be stated that they were conducted in highly controlled settings with a large degree of supervision during the training sessions leading to high adherence rates (≥85% performed of the prescribed) to the training interventions. Other studies, using less controlled settings, have reported substantially lower adherence rates and less convincing effects on glycemic control parameters (Thorsen et al. 2022*b*; Kitajima et al. 2023). As such, IWT-induced improvements in glycemic control are most likely dependent on high training adherence rates, something which will be discussed further below.

To summarize, the evidence shows that IWT results in superior improvements in glycemic control among individuals with T2D when compared to energy-expenditure and duration-matched CWT, independent of changes in body composition. The effects of IWT on glycemic control seem to be directly attributable to improvements in glucose effectiveness.

Nonmetabolic diseases/conditions

While IWT has been tested thoroughly in individuals with T2D, only a few studies have evaluated the potential health benefits in individuals with other diseases.

First, in a controlled study, patients with locally advanced colorectal cancer who had undergone primary cancer surgery were randomized to IWT or standard of care for 3 months (Christensen et al. 2019). Although IWT did not have a statistically significant effect on VO_{2peak}, improvements in glycemic control, insulin sensitivity, and body composition were seen. Moreover, some indications on improvements in quality of life with IWT were encountered. However, the size and length of the study prevented any evaluation of potential effects on cancer-specific variables.

In another study, patients who had undergone total hip arthroplasty at least 2 months earlier were randomized to 12 weeks of IWT or standard of care (Morishima et al. 2014). Data indicated that IWT was implementable in this population and improved VO_{2peak}. Furthermore, individuals in the IWT group improved knee flexion force on the operated side more, on average, than individuals in the standard of care group, with a tendency for the same regarding knee extension force. On the other hand, no differences in knee extension/flexion forces were seen between IWT and standard of care on the nonoperated side. As such, IWT may be a feasible addition to the rehabilitation program after hip arthroplasty, which may help regaining strength in the operated and, therefore, weakened leg.

To sum up, only a few studies have evaluated the health benefits of IWT in chronic, nonmetabolic diseases. Based on the limited evidence, IWT seems feasible and may induce various health benefits in individuals with various nonmetabolic diseases. It must, however, be noticed that these studies have not included a CWT group, meaning that it is unknown whether the apparent health benefits of IWT are specific to this intervention or whether such benefits would be seen with other training interventions as well. As such, more evidence is needed regarding the effects of IWT in nonmetabolic diseases.

Safety aspects

Historically, high-intensity training, including interval training, was considered potentially detrimental for individuals with chronic diseases, such as T2D. For example, a position stand on exercise and T2D from the American College of Sports Medicine, published in 2000, stated “For the majority of persons with type 2 diabetes, low-to-moderate intensity physical activity is recommended”, since this “minimizes the risks and maximizes the health benefits associated with physical activity for this population” (Albright et al. 2000). Whereas this view has changed in later versions of the position stand, safety concerns may still be expressed for individuals with chronic diseases who are prescribed interval training regimes.

In general, interval training regimes are considered safe, also in individuals with cardiovascular disease and diabetes who are typically considered high-risk populations (Wewege et al. 2018; Hwang et al. 2019). As previously stated, IWT is less intense than other interval-based training regimes, meaning that the potential concerns are probably even lower. Whereas not all studies have systematically reported safety aspects of IWT, there are no indications in the published literature that IWT is associated with major safety concerns or causes adverse events (Thorsen et al. 2022*b*). That said, individuals who are included in clinical studies are typically required to meet strict in- and exclusion criteria, and so individuals at risk will often not be included in such studies. As such, despite no data indicate safety concerns regarding IWT, it cannot be ruled out for individuals at risk.

Adherence to IWT

Adherence (calculated as the percent of prescribed sessions completed) to supervised or semisupervised IWT in shorter interventions (up to 6 months) is generally reported to be high, typically ranging from 80% to 100% (Masuki et al. 2020). Regarding long-term adherence in less supervised settings, only a few investigations exist, and they have been carried out in distinct settings in Denmark and Japan.

In Denmark, the InterWalk smartphone application (app) was developed for use in Danish contexts. This app was designed based on the principles underlying the JD mate (the accelerometer-based device used in the early IWT studies). The app leverages smartphone accelerometers and uses a 7-min walking fitness test to tailor personalized walking intensities (Brinkløv et al. 2016). The app’s design and functionalities were devised collaboratively in individuals with T2D, the Danish Diabetes Association, and healthcare professionals. Following development, the app was publicly released and received substantial attention, with 32 000 downloads within the first 2 years (Ried-Larsen et al. 2016*a*). Individuals downloading the app were more likely to be overweight or obese, suggesting its relevance for a population at risk. However, subsequent analyses indicated that only a minority sustained usage of the app beyond the initial download (Ried-Larsen et al. 2016*b*). This highlights the necessity for structured support to facilitate ongoing engagement.

The InterWalk app was incorporated and tested in a clinical setting in municipality-based lifestyle education programs for individuals with T2D (mean age 59.6 years). Here, the aim was to increase long-term engagement in moderate-and-vigorous physical activity measured objectively (Valentiner et al. 2017; Thorsen et al. 2022*b*). The design of the intervention was informed by user involvement and findings from a feasibility study supporting use of ecological momentary assessment (Office for Health Improvement and Disparities 2020), personalized phone calls, and goal setting (Valentiner et al. 2019), since these factors are generally accepted to increase adherence to free-living training interventions (Treat-Jacobson et al. 2019). While the attempt to embed IWT within the clinical environment yielded no discernible effects on moderate-and-vigorous intensity physical activity levels and was marked by a substantial attrition rate (39%), a clinically relevant improvement in health-related quality of life was observed (Thorsen et al. 2022*b*). Adherence to the IWT regimen during the initial 12-week phase of the program was modest and varied. Despite the supervised public rehabilitation setting using a group format, participants averaged only 38 min of IWT per week out of the prescribed range of 90–180 min per week (Thorsen et al. 2022*b*). Following the initial 12 weeks and up to the 52-week follow-up, participants engaged in IWT independently at home, facilitated by the InterWalk app. Despite offering opportunities for group-based walking activities and motivational interviews, the adherence remained low, at only 9 min per week. Encouragingly, post hoc analyses exploring the relationship between IWT duration and waist circumference showed that each additional 10 min of IWT correlated with a reduction of 0.6 cm in waist circumference, suggesting that the undertaken IWT was of adequate intensity and quality to confer health benefits (Thorsen et al. 2022*b*). That said, the very low overall adherence rate clearly indicates a challenge.

On the other hand, a study in Japan assessing long-term adherence to IWT included middle- and older-aged (mean age 65 years) healthy individuals and prescribed a 22-month IWT intervention using the JD Mate (Masuki et al. 2015). Adherence rate was assessed as the fraction of individuals who performed at least 4 weekly training days with at least five repeated cycles of fast and slow walking. Initial adherence during the first 6 months was high (above 90%) but declined somewhat during the intervention period, ending up at approximately 60% (equal to 45 min of fast walking per week) in the end of the intervention. Interestingly, the decline in adherence rates over time was higher in individuals with higher BMI levels, meaning that individuals who were overweight or obese at baseline would potentially need further support to maintain long-term adherence to IWT. As such, despite the substantial differences between populations in long-term adherence to IWT can be due to several factors, there seems to be a particular challenge in maintaining long-term adherence in individuals with overweight/obesity and/or T2D.

To summarize these experiences, the maintenance of long-term adherence to IWT is challenging, especially in individuals with overweight/obesity and/or T2D. The fact that individuals who volunteer to be included in exercise training studies are most likely more adherent than the background population further underlines the challenge. Given that the health benefits in such populations are of special interest, securing long-term adherence to exercise regimens, including IWT, warrants increased attention. Additionally, it is plausible that the lower adherence is attributed to varying levels of health technology readiness pertaining to intervention delivery via electronic devices (Thorsen et al. 2020), and potentially a lack of integration between the practice of IWT and participants' day-to-day lives within the intervention delivery (Thorsen et al. 2022*a*).

Conclusions and future directions

The health benefits of IWT are well established both in middle- and older-aged but otherwise healthy individuals and in individuals with metabolic diseases. Health benefits in populations with other diseases may also exist but have been less investigated. Studies have mainly been conducted under carefully controlled circumstances and in shorter term interventions, evaluating surrogate endpoints. As such, longer term studies — ideally in less controlled free-living settings — are needed and the effects of IWT on hard endpoints must be elucidated. Based on the published literature, there are no general safety concerns regarding IWT, neither in healthy individuals nor in individuals with chronic diseases.

Long-term adherence to exercise training programs, including IWT, is challenging to obtain. Real-world health benefits will only prevail if long-term adherence is secured in the broad population. As such, maintenance of adherence to exercise interventions is an area that needs continued focus.

Take-home message

IWT is a feasible and effective training regimen for older, fragile individuals. It significantly enhances fitness, muscle strength, and health markers. While safe, ensuring consistent long-term adherence remains a challenge for widespread benefits.

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This manuscript does not report data.

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Competing interests

TPJS has given invited talks at societal conferences and university/pharmaceutical symposia for which travel and accommodation were paid for by the organizers. He has consulted for Boost Treadmills, GU Energy, and Examine.com, and owns a consulting business, Blazon Scientific, and an endurance athlete education business, Veohtu. These companies have had no control over the research design, data analysis, or publication outcomes of this work. MR-L has received speakers fee from Astra Zenica A/S and serves on the Educational Committee at the Danish Diabetes and Endocrine Academy that is supported by the Novo Nordisk Foundation. MR-L is supported by the Centre for Physical Activity Research from grants from Trygfonden (ID 101390, ID 20045, and ID 125132). The remaining authors declare no relevant conflicts of interest.

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