In: Science of Sport, Exercise and Physical Activity … ISBN: 978-1-63117-737-8
Editors: Andrew Edwards and Anthony Leicht

Chapter 14

PHYSICAL ACTIVITY BEHAVIOUR IN THE TROPICS

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ABSTRACT

First we reviewed studies examining the role of climate on physical activity (PA) behavior. This highlights the limited knowledge and guidelines currently exist on the moderating influence of a tropical or hot climate on the PA behaviors of individuals.

Secondly, we examined the role climate on PA in children and clinically obese individuals. Contrary to previous findings from Caucasian young children, our data on habitual PA levels in Hong Kong primary school-aged children seem to suggest no seasonal variations. From the Chinese medicinal perspective, 'sweating' was considered as a sign of good health as expressed by the Hong Kong young children we recently interviewed. Therefore, Hong Kong children and parents may regard PA in the heat as beneficial to health. Alternatively, the increasing physiological evidence indicates that young children's thermoregulatory ability during exercise in the heat is not necessarily inferior to that of adults, thus biologically, children's habitual PA may not be prone to climatic changes in the tropics as commonly believed. Given the possible subjective climatic constraints, Hong Kong young children appear to favor indoor sporting options like swimming and activities that are likely to generate 'breeziness'.

All of the above arguments appear to lend support to human's adaptiveness to their environmental demands. Finally we discuss the difficulties and barriers to exercise of morbidly obese women in thermally comfortable conditions. We will extrapolate findings to tropical conditions, examining the likelihood of exercising with severe obesity in the tropics. We conclude that humans adapt to their environmental demands.

However, there is a need to examine the influence of humid tropical conditions on physical activity and exercise behavior and develop evidence based guidelines for these environmental conditions.

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INTRODUCTION

The tropics are most commonly defined as the region with a latitude of + 23.5 degrees (Cancer) or -23.5 degrees (Capricorn) of the Equator. This area is characterised by relatively little variation in seasonal changes in day-to-day temperature (mean temperature for all 12 months > 18°C). In addition, the weather is characterised by humid conditions with rainfall exceeding evapotranspiration on more than 270 days per year. Finally, the tropics have a 12-hour night/day cycle throughout the year.

It was Aristotle who divided the world into 3 zones based on climate: Frigid, Temperate and Torrid zones. The Torrid zone is what we now know as the tropics, and according to Aristotle it was unsuitable for human habituation or productive work. Although the world has been viewed in many ways during the centuries the distinction made by Aristotle is an important one and the publication of this book is a testament to this.

Currently 40% of the world population resides in the tropics, up from 30% in 1950 and expected to be 50% by 2050. Also, 144 nations are geographically located partly or fully in the tropics [44]. Economically, the region only produces 20% of the global economic output, thus individuals in many tropical regions are less well-off compared to individuals in other zones. This is reflected in lower life expectancy (7.7 years) and higher infant mortality (25 more deaths per 1,000 births) in comparison to the rest of the world. However, these gaps are decreasing rapidly. In addition, the lifestyle diseases and issues which are prevalent in other regions of the world like obesity, diabetes and physical inactivity are also becoming a burden for the tropical regions.

SPORT AND EXERCISE IN THE TROPICS

There is an abundance of information on physiological acclimatisation (functional compensation made over several weeks of exposure to a new environment) to exercise and sport participation in hot conditions. Most studies have examined acclimatisation responses to hot/dry conditions in controlled laboratory rather than to hot/humid conditions. For example, it is now assumed that 8-14 days of acclimatisation result in increased cardiac output, sweat rate and onset, blood plasma volume, and a decrease in heart rate, core body temperature, and skin and rectal temperature at rest. These processes are moderated by age and fitness level with fitter and younger people showing better acclimatization [1, 10].

Unfortunately, very few studies have examined acclimatisation to hot/humid outdoor conditions. It appears that the natural response to hot/humid outdoor conditions actually results in an increase in rectal temperature at rest, increased heart rate and overall physiological strain [10, 23]. To support these findings, a study examining adaptation (long-term adjustments) to tropical climate found that native Japanese women who resided for more than two years in a hot and humid tropical climate developed heat tolerance indexed by a delayed onset in sweating and reduced sweat volume compared to native Japanese women who resided in Japan [2]. Suppressed sweating would be beneficial to the individual because it preserves body fluids and osmoregulation. However, this response is less likely to support high intensity exercise over a sustained period of time [23].

Genetic factors have also been shown to play a role in maintaining heat balance. Soon after birth the number of sweat glands activated by the sympathetic nervous system through cholinergic activation is determined. This number is higher in infants in hot/humid conditions despite the fact that sweating is less important to maintain heat balance in infants as they have higher surface to volume ratio. This development sets up the individual to a pattern of thermoregulation throughout life [21].

PHYSICAL ACTIVITY IN THE TROPICS

Qualitative studies have indicated that the weather (humidity, rain, temperature) is perceived as a barrier for individuals to engage in regular physical activity (PA), but it did not appear to be an issue when the activities are perceived as enjoyable [41]. The role of the weather is apparent in studies which have examined seasonal variations in PA behaviour. Most of these studies have been conducted in temperate climates showing increased PA during the summer months (or spring/ fall depending on temperatures in the summer) in comparison to the winter months [42].

The role of the weather on PA behaviour is varied and not clear cut. This can be illustrated by comparing two studies which investigated PA behaviour in elderly individuals in temperate climates in Ulm, Germany [25] and Nakanojo, Japan [47]. As can be seen from Table 1, weather factors influenced PA behaviour differently in the elderly participants. For example, in Ulm, increased temperature was associated with more PA. However, in Nakanojo there was a quadratic relationship. The most PA took place with temperatures around 17°C with a decrease in PA with higher temperatures. This was reflected in most PA taking place in this population during the spring and autumn months. Humidity also influenced PA behaviour differently. A positive but small relationship was found in the Nakanojo study and a negative relationship in the study conducted in Ulm.

Two studies from the United States, conducted in a temperate climate, provide additional information on how the weather might interact with the built environment to determine outdoor PA behaviour. In one study, it was shown that temperature, relative humidity and rainfall explained 42% of the variance in the use of an urban Greenway [5]. However, temperature alone only explained 18% of the variance and usage only increased up to 24°C. This study also showed that hour of the day, day of the week (weekend or weekday), month of the year and air quality moderated the usage, with lower usage during weekdays and at higher temperature associated with poorer air quality. However, in an observational study, higher temperatures were associated with more and longer use of an oval track whereas dew point had an inverse relationship, but metrological conditions had little influence on PA behaviours on sidewalk/streets and PA to school [45].

As indicated the literature discussed so far has examined PA behaviour in temperate climates. The influence of a hot/humid tropical climate on PA behaviour has not been examined extensively and the results are equivocal. It appears that those living in the moist tropical regions of the United States were most likely to be in the bottom 25% of meeting the recommendations for PA [32].

Also, an intervention study conducted in Hong Kong to increase stair walking was not successful contrary to previous findings obtained in non-tropical conditions [18].

Table 1. Comparison of the influence of weather conditions on the physical activity behaviour of elderly individuals in Ulm, Germany and Nakanojo, Japan

Study	Kenke et al., 2011	Togo et al., 2005
Location	Ulm, Germany	Nakanojo, Japan
Number of participants	1324 (m = 747; f = 577)	41 (m = 20 f = 21)
Participants age	74.6 years	71.4 years
Activity assessment	ActivPal: Mean daily walking duration (5 days; over 12 months)	Pedometer: Daily step count over 14 month period (450 days)
Rain	Negative relationship: Less PA with more rain	Negative relationship: Less PA with more rain (R^2= .19)
Radiation/sunshine	Linear increase: More PA with increasing temperature	Small linear increase: More PA on days with sunshine (> 360 minutes) (R^2 = .03)
Temperature	Linear increase: More PA with increasing temperature	Quadratic relationship increase in PA up to 17C than decrease (most PA in spring and autumn) (R^2 = .32)
Daylight	Linear increase: More PA on longer days	Linear increase: More PA on longer days (R^2 = .13)
Humidity	Negative relationship: Less PA with increased humidity	Small linear increase: More PA with increasing humidity (R^2 = .03)
Wind speed	Small negative relationship: Higher wind less PA	No relationship

The researchers only observed an increase in walking up the escalator by the Asian population but not the non-Asian population. The authors concluded that ‘it would be unwise to assume that life style physical activity interventions have universal application. The contexts in which behaviours occur, e.g., climate, might be a barrier to successful behavioural change” (p. 1290).

The potential of community PA interventions to sustained improvements in PA across the population was emphasized in a recent review [33]. The authors highlighted population interventions conducted in Norway (Batsfjord, Romsas), Belgium (Ghent), Canada (Saskatoon), US (Wheeling) and Australia (Rockhamp-ton), but none of these interventions took place in a hot/humid tropic climate, nor specific guidelines for PA interventions in such environments are available to date.

Overall, current knowledge of PA behaviour in hot/humid tropical conditions is limited to say at best, and comprehensive guidelines for PA in such environments are called for. There is not only a need to examine the physiological responses and adaptations to such environments, but also to investigate the psychological factors associated with PA behaviour in the tropics, such as an elevated rate of perceived exertion in hot/humid conditions [23].

In the next two sections we will discuss the role of the tropical climate on PA behaviour in two specific populations. First the seasonal variability in Hong Kong school children will be discussed followed by a section highlighting difficulties morbidly obese women experienced when trying to exercise.

SEASONAL VARIABILITY IN PA IN HONG KONG CHILDREN

Like the research on elderly population, there is also consistent evidence to show the impact of seasonality on children's habitual PA, with PA generally higher in summer and spring than in winter and autumn [8, 35]. For instance, increased free-living PA in school-aged children is associated with temperature increases and lower rainfall [18].

Similarly, both genders engaged in significantly more bouts of PA of all intensities in summer than in winter and girls engaged in PA more frequently as well [39]. As with the elderly, most of these studies were conducted in the West, such as North America, Australia, New Zealand and Europe, where climatic conditions are relatively distinct between seasons.

Findings are largely similar regardless of the modes of PA measurements e.g., pedometry and observations, or study design. It is suggested that the more moderate temperature and longer sunlight hours during summer and spring are likely to be more conducive to outdoor activities that constitute a major part of children's daily PA [43].

For this reason, PA variations might not be as prominent in regions where climatic conditions are less distinct across seasons, such as parts of Asia that are subject to the tropical monsoon climate characterised by relatively small variance in temperature throughout the year, but with more notable wet and dry seasons.

Arguably, the climatic conditions during autumn in such regions might even be more suited to outdoor activities, compared to winter or spring due to the milder temperature and lower humidity level respectively. Additionally, since children mostly engage in short bouts of low intensity PA (approximately 12 mins/bout) with rest intervals twice as long between bouts [3], it is unlikely that this PA pattern would result in heat stress during the summer months for a healthy child [23]. Therefore, even if seasonal PA variations do exist in children who are tropic natives, habitual PA level might be higher in summer and autumn compared to that in winter and spring.

With Hong Kong's climatic conditions following the typical tropical monsoon climate, with relatively small monthly temperature variations but a more pronounced dry season, we tested our hypothesis by comparing the habitual PA level of Hong Kong children (aged 9-12) over summer/autumn (September – December) and winter/spring (January – April) [27].

Are There Seasonal PA Variations in Hong Kong Children?

Participants in our study were recruited from two local government schools in Hong Kong (aged 9-12 yrs; n = 156). Participants from each school were scheduled for testing either in summer/autumn (Group 1; September – December 2008) or in winter/spring (Group 2; January – April 2009). Table 2 presents a summary of the climatic conditions in Hong Kong during the two data collection periods.

In the morning of a normal school day, participants' stature and body mass were recorded using a fixed stadiometer (to the nearest 0.1cm; Invicta 2007246, UK) and a bioimpedience scale (to the nearest 0.1 kg; Tanita TBF-410 Japan) respectively.

An adjustable nylon belt was provided for attaching a pedometer (New Lifestyle NL-100) on the left hip and for standardizing the tilt angle at which the pedometers were worn [16].

Table 2. Climatic conditions in Hong Kong during the two PA measurement periods

	Temperature (°C)	Relative humidity (%)	Rainfall (mm)	Sunshine duration (hours)
Summer/autumn (Group 1)	24.0 ± 4.7	70.0 ± 7.0	91.8 ± 72.1	199.8 ± 17.9
Winter/spring (Group 2)	19.4 ± 2.9	76.3 ± 8.5	57.6 ± 66.1	139.2 ± 66.3

Table 3. Mean age and mean BMI (in kg/m^2) for both genders in each group

	n (boy, girl)	Mean age ± SD	Mean BMI ± SD
Summer/autumn (Group 1)	115 (55, 60)	9.9 ± .5	18.4 ± 3.8 (boys); 18.2 ± 3.1 (girls)
Winter/spring (Group 2)	41 (25, 16)	10.7 ± .9	19.3 ± 4.1 (boys); 17.2 ± 2.9 (girls)

All participants were instructed to wear the pedometers for eight consecutive weeks. Table 3 shows the gender composition, age and body mass index (BMI) for each group. Step inclusion criteria included data between 2,000 and 30,000 steps (inclusive) for analysis as 2,000 steps was felt to be a realistic minimum in a school environment and 30,000 was considered a credible maximum (24). Additionally, those with one weekday of data were included in the final analyses (25). Only PA data from the third week were used for analysis as the first two weeks of measurement might represent pedometry reactivity [27].

One-way Analysis of Variance was conducted to examine group differences in mean daily steps, with gender and BMI accounted for. Mean daily steps were 7894.09 ± 2415.54 and 8408.13 ± 2918.30 for Group 1 and Group 2 respectively. No significant difference in habitual PA was observed between the two groups ($p > .05$; $\eta^2 = .01$), suggesting that seasonal PA variations might not be applicable to Hong Kong children.

Why Might Seasonal PA Variations Be Not Observed in Hong Kong Children?

A few possible reasons might explain our findings. First, the study limitations must be considered. For instance, our sample size and cross-sectional study design might be limited to detect a bigger effect. Moreover, the two measurement periods might be too close for a more drastic change in climatic conditions. Although previous research has suggested to measure habitual PA in the main summer months and to compare it with that in the main winter months [8], data from these two distinct seasons might not be directly comparable as the difference in the schooling schedule over these two periods may confound the findings.

Considering a premise behind seasonal variations in children’s habitual PA is that the milder climatic conditions are more conducive to outdoor activities. However, certain environmental factors that might affect outdoor pursuits, namely air quality and availability of indoor recreational infrastructure.

Compiling data from the World Health Organization and the Environmental Protection Department (Hong Kong), Hong Kong is ranked 8th in mortalities due to air pollution out of the 193 countries evaluated [11]. Hong Kong’s air pollution is largely affected by the industrial activities in Mainland China and also by factors such as vehicular emissions within the city. Air pollution concerns are particularly severe during autumn and winter due to the lack of rainfall.

Coincidentally, our study was also conducted during the more heavily polluted seasons when the general public was advised to avoid prolonged outdoor activities for respiratory health reasons, which covered approximately 70% of our entire data collection period [17].

Nonetheless, the relatively comprehensive indoor recreational infrastructure in Hong Kong might counter the influence of the undesirable air quality on PA. There are altogether 101 public indoor sports complexes (mostly air-conditioned) within the city with a larger number of complexes in the more populated areas. Each indoor sports complex comprises a variety of sporting facilities, such as swimming pools, basketball, squash, and badminton courts. Moreover, a recent survey showed that ball games and swimming are the most favourite sporting activities for school-aged Hong Kong children [43], thus with the availability of these indoor recreational facilities, the climatic conditions or air quality issue might not impose much impact on PA engagement. From the cultural perspective, climatic conditions do not appear to be a concern for Hong Kong children from our existing focus group qualitative data [28]. In fact, Hong Kong children appear to value PA in the heat as they believe that the toxins in the body can be rid of through sweating which seems to be a common belief that originates from Chinese medicinal knowledge [26].

> “When you exercise, the bad stuff in the body will come out with the sweat.” (boy, 11 yrs)

Another prominent factor that seems to attract Hong Kong children to PA is the positive body sensations during participation.

> “… when you’re cycling very fast, you can feel the wind and it feels cool.” (girl, 9 yrs)

> "I like swimming, coz… I'll be allowed to go to the jacuzzi pool to play, the water there is very hot and very warm." (boy, 6 yrs)

From the themes which emerged from the focus group discussions, the climatic conditions do not appear to hinder PA participation for Hong Kong children. They may even seem to enjoy the heat generated from the body or from the immediate environment for cultural or personal sensory reasons. The latter may also explain why swimming is among the most favourite PA mentioned earlier.

Summary of Findings

Contrary to previous research, our existing data do not seem to support seasonal variations in habitual PA in Hong Kong children. It is possible that the study limitations might affect the findings, nonetheless, certain environmental and cultural factors should also be considered when examining the influence of climatic conditions to children's habitual PA especially for research conducted outside the western environment and culture, and particularly in the tropical regions where the climatic conditions may present somewhat different challenges to PA participation than from the non-tropical areas.

Such research direction can potentially inform future PA interventions for young children in the tropics and may even extend to government policies with regards to the provision of recreational infrastructure in the regions of interest.

BARRIERS TO PA WHEN MORBIDLY OBESE

Obesity is defined as an excessive accumulation of fat with body mass index (BMI) ≥ 30 kg/m^2 as a threshold [49]. Morbid obesity is defined as a BMI ≥ 35 kg/m^2 with a least one co-morbid condition or BMI ≥ 40 kg/m^2 [31]. There is a distinct lack of scientific literature on the physical and psychological effects of exercise on obese individuals living in the tropics, therefore in this section mainly general barriers to exercise will be discussed.

It has been long acknowledged that PA participation improves general health independent of an individual's size, as fitness appears to be a greater determinant of disease and mortality than fatness, especially when there is a high dose and PA relationship [19]. Fitness is defined as a "set of attributes that people have or achieve, and the ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforseen emergencies" [9] (p. 126). In the past PA alone was seen to be an insufficient method for weight loss for morbidly obese, but the evidence for these assumptions are problematic and often are methodologically flawed. For example, the age and BMI of participants in exercise groups in obesity intervention studies appear to be significantly lower (36.5 years; BMI ≥ 26.4 kg/m^2) in comparison to participants in diet (40 years; BMI ≥ 34.9 kg/m^2) and diet-plus-exercise (39.5 years; BMI ≥ 34.8 kg/m^2) [38].

Also, those in the exercise only conditions are not obese, but only marginally overweight, which means that they are unlikely to experience obesity related movement restrictions and functional limitations. The types of exercises in these interventions were also less strenuous and usually varied between light and moderate intensity.

Therefore, completing only minimal volumes of exercise (frequency, types, duration, and intensity) is unlikely to yield great weight loss benefits. The most commonly cited barriers to exercise in the obese and morbidly obese are: functional limitations due to excess adipose tissue, physical health problems (co-morbidities), pain, perceptions of exercise being boring, lack of time, costs of gyms, subscriptions, and personal trainers, lack of suitable facilities to exercise (no individual dressing rooms, safe furniture, including no reinforced bathroom utilities), unsafe neighbourhoods and body image perceptions [4, 50].

The risk of orthopaedic injury is also often poorly understood by those who attempt to run exercise interventions programmes for the morbidly obese, unless the intervention took place in a very controlled environment, under strict supervision, whilst monitoring physical health.

It has been shown that abnormal distribution of body fat in the abdominal area (high waist circumference) is associated with reduced postural control and stability that can lead to falls [50], and makes motor planning and adaptation to exercise difficult [48].

Considering these well known barriers in thermally comfortable climates, many researchers have questioned obese individuals' ability to a) embark on an exercise regime and b) to sustain it overtime [46]. The National Health Survey 2007-2008 reported that only 28% of Australians aged 15 years or more exercised enough for health benefits.

Similarly, in one study 52% of type II diabetic and 56% of obese patients were less likely to adhere to cardiac rehabilitation classes than their non-diabetic and non-obese counterparts [20]. Poor adherence was more pronounced among individuals with higher adiposity and previously less active or more sedentary. Lack of previous exercise experience, being sedentary, coupled with reduced capacity to exercise due to obesity has the potential to reduce exercise self-efficacy, result in poor body image, thereby making individuals less likely to adhere to exercise programs. A recent systematic review [34] on levels and predictors of exercise referral schemes based on 6 randomized control trials and 14 observational studies that met the inclusion criteria concluded that without a standard definition it was difficult to compare study results. Few of these considered analysis by gender and age, but results showed that women were more likely to start the exercise program, but also more likely to dropout than men. Older people were more likely to start and adhere to such programs. Levels of adherence were similar across study types around 43%, which is considered to be very low. There was no weight related breakdown of adherence, but given the barriers obese individuals report, levels lower than 43% adherence would be expected.

To our knowledge, there is only one study that explored the psychological burden of exercise on obese individuals in the tropics [22]. The results of the study also confirmed that given the barriers to exercise these individuals experience, it is unlikely that they would take up exercise and be able to maintain it if they did.

ENVIRONMENTAL FACTORS INFLUENCING EXERCISE DECISIONS

There is considerable evidence for exercising and being outdoors and in nature as much more beneficial for mental health compared to exercising in a gym or indoors [40, 29]. As discussed, seasonal variation in temperature is known to effect exercise decision of individuals. Behavioural adaptation to cold is easier, because it is easy to restore thermal equilibrium by wearing more clothing. Exercising outdoors in the heat is therefore much more challenging.

To our knowledge there are no studies exploring obese individuals' physiological responses elicited by hot/humid climate. Given that non-obese found to respond with reducing the metabolic heat production, thus the intensity of exercise and aerobic activities (swimming, cycling, running) tend to induce high thermoregulatory stress in such climates [24], it is unlikely that obese individuals are able to exercise for health benefits. Individuals with smaller body mass were found to adapt better to hot/humid conditions [14].

Future research should investigate heat tolerance, cardiac output, stroke volume, sweat rate, blood plasma volume, heart rate, core, rectal, and mean skin temperature of obese at both rest, when exercising and as a consequence of long-term adaptation.

Trials and Tribulations When Working with Obese in an Exercise Setting

There are numerous anomalies of exercise research with obese. Why do we know so little about exercise and morbid obesity? To date, when examining recruitment criteria in published studies, the majority excludes individuals with BMI of 35 and above. There are very few randomized control trials with morbidly obese, but the Weight, Healthy Eating, and Exercise in Leeds (WHEEL) was such a study [4]. It was designed to help obese women to embark on an exercise programme, which was tailored to their needs. The aim of the project was to provide pre-menopausal moderately to severely obese women with a client centred weight management programme, using the Health @ Every Size [36] approach and the Self-determination Theory's framework [13]. Sixty two women participated in the study and were randomly assigned to experimental and delayed control start groups.

WHEEL, a delayed start RCT was conducted over 1 year (3 months intensive intervention and 9 months maintenance phases). The intervention consisted of 4 hours of structured exercise a week (2x1 hr circuit class, 1x1 hr Tai Chi, and 1x1 hr Aqua aerobic class) and it took place at a university campus and local authority leisure facilities. In the Maintenance phase participants just continued with the exercise activities. They were required to attend a minimum of two sessions in the structured classes and another 2 hours by their own arrangements. It was found that individuals with high weight status (Mean BMI 38.6; ±7.6) benefitted from exercise interventions. Their cardiorespiratory fitness improved significantly in the intervention group (9.3% increase adjusted VO_2 $ml.kg^{-1}min^{-1}$; 7.8% increase absolute VO_2 $ml.kg^{-1}min^{-1}$) as compared to controls (4% reduction adjusted VO_2 $ml.kg^{-1}min^{-1}$; 3.2% increase absolute VO_2 $ml.kg^{-1}min^{-1}$). Benefits of exercise reported were: psycho-social functioning (including social capital of exercise participation); improvements in flexibility, movement and functional ability; exercise self-efficacy and self-regulation, fitness and metabolic profiles [6, 7]. There were many trials and tribulations when working with moderate to severely obese women. In-depth weight history interviews (pre and post), comprehensive quantitative psychological and physiological measures indicated that participants had a markedly different health profile to those with lower weight status. In particular, movement limitations, perceived and actual pain, high prevalence of depressive symptoms and poor general well-being scores put these women at a much higher risk in an exercise setting, as well as a risk of dropping out. The trials included finding suppliers of exercise attires (mostly they were in the US) large enough to fit, buying training shoes, as many have not owned a pair; reconsidering standard exercise prescriptions, as many of the exercises didn't suit or was not able to be delivered safely; finding exercise facilities where there were individual cubicles in the changing rooms; and car parking places and easy parking to venues. Suitability of exercise settings for this population is rarely examined, which could improve adherence rates. For sustainability reasons, the project worked with a local authority employee, who after the research project ended continued with the classes. All the exercise components were designed based on available evidence and guided by industry guidelines.

However, in practice, in the circuit classes even after these adaptations there was a need to slow down the music further, banning sharp turns, and steps, fitting each participant with a heart rate monitor and teaching them to alert us if there was a problem and offering a sitting alternative to each routine.

In conclusion, should we offer research driven exercise interventions for the morbidly obese? Yes, despite the trials and lack of significant weight loss, their psychological and physical health (metabolic profile) improved significantly.

To make such interventions effective, the exercise context (environment) has to be researched thoroughly. It is advised to measure their psycho-social functioning, obesity related physical limitations, exercise self-regulations and self-efficacy and use these to identify those who will face higher barriers due to their condition. Those with poor psychological and physical profiles should have a behavioural 'pre-intervention' to increase their readiness for participation in an actual exercise programme or delay participation due to medical intervention (e.g., depression, sleep-apnea, high blood pressure).

CONCLUSION

What is clear from this chapter is that we have to examine more closely the role of the tropical climate on PA behaviour from both the physiological and psychological perspectives. Few guidelines currently exist for people to engage in PA in the tropics other than the obvious ones (maintain hydration, exercise early in the morning or late afternoon). Also, the role of different PA modalities needs further investigation. Although swimming appears to be the choice of activity for many and is suited for tropical climates, this is not without risks for the obese. Hence, if the water temperature is high than this has significant consequences for maintaining heat balance [4]. There is even less information available for specific populations like obese children and adults and the elderly.

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