Diabetes, Metabolic Syndrome and Obesity

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ORIGINAL RESEARCH

Validity of the Arabic International Physical Activity Questionnaire to Measure Moderate-to-Vigorous Physical Activity in People with Diabetes

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Purpose: The aim of this cross-sectional study was to compare the Arabic version of International Physical Activity Questionnaire (IPAQ) measured moderate-to-vigorous physical activity (MVPA) with accelerometer-measured MVPA in people with diabetes.

Methods: From 2020 to 2022 physical activity was measured people ≥18 years with type 1 or type 2 diabetes in Kuwait. Self-reported MVPA was measured over 7 days with the Arabic version of the IPAQ. During the same 7-day period wrist worn accelerometers were used to objectively measure MVPA. IPAQ MVPA was calculated both including and excluding walking physical activity. MVPA measures were compared by limits of agreement approach, Pearson correlations and concordance correlations.

Results: We recruited 240 participants with type 1 diabetes and 343 participants with type 2 diabetes for the study. In people with type 1 diabetes, there were no concordance correlations between IPAQ MVPA, both including (rho = −0.011 (−0.038, 0.017), p = 0.444) and excluding (rho = −0.001 (−0.067, 0.065), p = 0.978) walking physical activity. MVPA measured by IPAQ was 43.3(−85.6, 172.2) min/day higher than accelerometer-measured MVPA, when including walking, and 8.88(−60.4, 78.2) min/day higher, when excluding walking. In people with type 2 diabetes, there were significant positive concordance correlations between IPAQ MVPA, both including (rho = 0.038 (0.02, 0.06), p < 0.001) and excluding (rho = 0.34 (0.27, 0.41), p < 0.001) walking physical activity. MVPA measured by IPAQ was 62.3 (95% CI −61.5 to 186.0) min/day higher than accelerometer-measured MVPA, when including walking, and 4.0 (95% CI −34.1 to 42.0) min/day higher, when excluding walking.

Conclusion: In people with type 1 or type 2 diabetes, caution should be exercised when using the Arabic version of the IPAQ to measure MVPA.

Keywords: metabolic disease, activity, Arab, validation

Introduction

Currently, 537 million adults (age: 20–79 years) worldwide are living with diabetes, with a current prevalence of 10%; this number is projected to reach 643 million by 2030 and 784 million by 2045.[1] In 2021, diabetes accounted for 6.7 million deaths globally.[1] Diabetes, both type 1 and type 2, increases the risk of microvascular diseases, such as neuropathy, nephropathy, and retinopathy, and macrovascular diseases, such as coronary artery disease, peripheral arterial disease, stroke, and other related complications.[2,3] Adults with type 1 and type 2 diabetes experience roughly 2–3x increased risk of cardiovascular disease, which accounts for ~80% of deaths for patients with these conditions.[4–6] Undeniably, diabetes is a global issue, but it is of particular concern in many Arabic countries, like Kuwait, where the age-adjusted comparative prevalence of diabetes in adults (age: 20–79 years) is estimated to be 24.9%.[1] This is the third highest prevalence of any country/territory in the world and is projected to increase to 29.8% in 2045.[1]

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The treatment of diabetes is multifaceted, comprising both pharmacological and lifestyle interventions. Recent years have witnessed significant advances in both pharmacological and lifestyle interventions, such as the successes of sodium-glucose cotransporter-2 (SGLT2) inhibitors and glucagon-like peptide-1 receptor agonist therapies, as well as low-calorie total diet replacement strategies[7–9] which are particularly useful in people with overweight or obesity. Another aspect of lifestyle that is crucial in preventing and managing diabetes is physical activity, the benefits of which include, but are not restricted to, reduced risk of CVD and improved glycaemic control.[10–13] While physical activity levels are usually low worldwide, this can be a particular issue in Arabic countries in the Middle East where high prevalence of insufficient physical activity (not meeting the World Health Organization (WHO) guidelines of 150 min/week of moderate of 75 min/week of vigorous or an equivalent combination of the two) has been reported with Kuwait, Saudi Arabia and Iraq having the 1st, 3rd and 4th highest prevalence of insufficient physical activity in the world.[14] For example, we have previously shown that only ~15% of adults with type 2 diabetes in Kuwait are sufficiently physically active.[15] Data on physical activity levels in the Arab world, which includes ~450million people, are scarce and are primarily based on Arabic versions of questionnaires such as the International Physical Activity Questionnaire (IPAQ) or the Global Physical Activity Questionnaire (GPAQ). Whilst this is informative, it is known that there can be misreporting of physical activity when using a questionnaire[16] and, furthermore, this can underestimate the strength of the relationship between physical activity and risk biomarkers.[17] To our knowledge, there has been no comparison of IPAQ measured moderate-to-vigorous physical activity (MVPA) with accelerometer-measured physical activity in people with diabetes in Kuwait.

The aim of the current study was to compare the Arabic version of IPAQ measured MVPA with accelerometer-measured MVPA in people with diabetes.

Materials and Methods

Study Setting and Participants

From 2020 to 2022 people with type 1 or type 2 diabetes aged ≥18 years, attending clinics or participating in ongoing research at the Dasman Diabetes Institute, were invited to participate in the study. The study was fully explained to the participants, both orally and in writing, prior to them providing written informed consent. The study was approved by the Dasman Diabetes Institute Ethical Review Committee and followed the guidelines set out in the Declaration of Helsinki.

Demographics

Demographic information was collected from electronic health records and included age, co-morbid conditions, medical history, body weight (kg), height (cm), BMI (kg/m^2), waist circumference (cm), and HbA1c (%).

Accelerometery

Participants were issued with a GENEActiv original accelerometer and instructed to wear this 24h per day for a 7-day period. The accelerometer was set to record at 100Hz. Data extraction and processing was performed using GGIR.[18] Acceleration data collected was calibrated to local gravity using the methods established by van Hees et al.[19] Physical activity levels were quantified using methods previously described[20,21] with thresholds of 40mg for light activity, 100mg for moderate activity and 400mg for vigorous activity. MVPA was quantified in bouts of at least 10 minutes using the following criteria (*boutcriter.mvpa = 0.8*) for interruptions, as previously suggested:[22] 1) A single interruption can last <1 min, 2) Repeated interruptions are allowed provided that their total time does not exceed 20% of the bout duration and 3) The time spent in the interruptions is included in the duration of the MVPA bout. A valid day was defined as having >16 hours of data in it, and we excluded participants with less than 3 valid days of data or if wear data were not present for each 15-minute period of the 24-hour cycle.

International Physical Activity Questionnaire

Physical activity was measured using the short-form Arabic Version of IPAQ that asks participants to report (in bouts of 10 mins or more) the amount of walking undertaken and participation in moderate and vigorous activities.[23] The IPAQ has walking as a separate activity from moderate activity, explicitly excluding walking in the moderate activity questions.

Depending on the intensity of walking, it can be classified as either light or moderate physical activity.[24] For comparisons with the accelerometer derived MVPA we, therefore, estimated MVPA (min/day) from the IPAQ, as (1 × moderate physical activity) + (2 × vigorous physical activity), both including and excluding walking time as a moderate physical activity.

Statistical Analysis

Data were analysed using R (Version 1.4.1717). Accelerometer and IPAQ MVPA (min/day) were compared using a limit of agreement approach.[25] Associations between accelerometer and IPAQ MVPA were assessed using Pearson correlations (r) and concordance correlation coefficients (rho). The latter correlation measures how far the best-fit line deviates from the 45° line (y=x), providing a composite measure of correlation and agreement.[26,27]

Results

Participants

The participant demographics of those included in the current study are presented in Table 1. In the group of people with type 1 diabetes, 48% of participants were females, with an average age of 45 years, HbA1c of 8.1%, duration of diabetes of 16 years, a BMI of 27.5 kg/m2 and a waist circumference of 88 cm. In the group of people with type 2 diabetes, 47.8% of participants were females, with an average age of 60 year, HbA1c of 7.7%, duration of diabetes of 17 years, a BMI of 31.6 kg/m2 and a waist circumference of 104 cm.

Comparison of IPAQ with Accelerometer Derived MVPA – People with Type 1 Diabetes

The correlations between IPAQ and accelerometer-measured MVPA are shown in Figure 1. When IPAQ MVPA including walking activity, no correlation (r = −0.05, 95% CI 0.18 to 0.08, p = 0.444) or concordance correlation (rho=−0.011, 95% CI −0.038 to 0.017, p = 0.444) was seen. When walking activity was excluded from IPAQ MVPA, no correlation (r = −0.03, 95% CI −0.13 to 0.12, p = 0.978) or concordance correlation (rho = −0.001, 95% CI −0.067 to 0.065, p = 0.978) was seen.

The Bland-Altman plots comparing IPAQ and accelerometer-measured MVPA are shown with IPAQ MVPA including (Figure 2A) and excluding (Figure 2B) walking physical activity as MVPA. When walking was included in the MVPA calculation, there was a mean difference in MVPA of 43.3(95% CI −85.6 to 172.2) min/day, being higher when

Table 1 Demographics and Physical Activity Data for Participants with Type 1 or 2 Diabetes in Kuwait

	Type 1 Diabetes (n=240)	**Type 2 Diabetes (n=343)**
Number of females (%)	116 (48)	164 (48)
Age (years)	44.77 (14.43)	60.17 (10.77)
HbA1c (%)	8.18 (1.64)	7.74 (1.47)
Duration of diabetes	16.50 (12.82)	17.35 (10.12)
Height (cm)	164.77 (9.12)	164.24 (9.95)
Body mass (kg)	74.67 (14.77)	85.19 (17.60)
BMI (kg/m^2)	27.47 (4.71)	31.60 (6.09)
Waist circumference	88.28 (14.09)	104.48 (13.58)
Accelerometer MVPA in 10 min bouts (min/day)	5.53 (10.16)	3.99 (10.44)
IPAQ MVPA (excluding walking) in 10 min bouts (min/day)	14.41 (33.84)	7.96 (21.65)
IPAQ MVPA (including walking) in 10 min bouts (min/day)	48.87 (64.47)	66.26 (64.75)

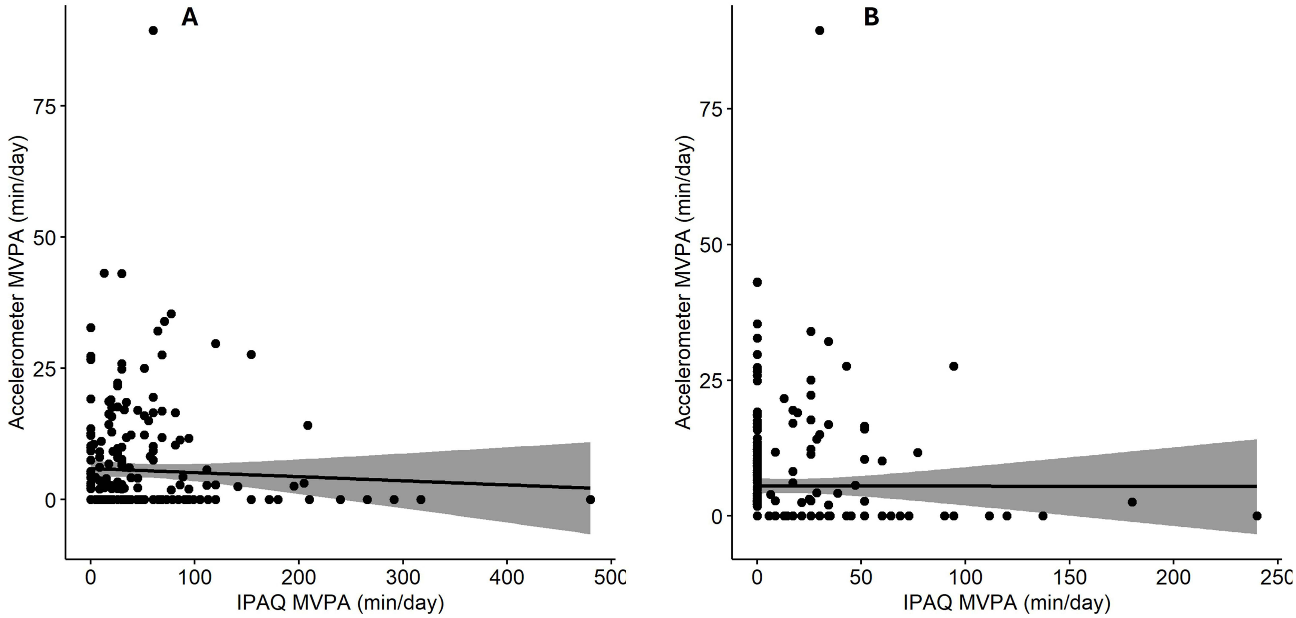

Figure 1 Correlation between MPVA measured using the IPAQ and accelerometer MVPA in people with type 1 diabetes. IPAQ MVPA includes walking, moderate and vigorous activity in (**A**) and only moderate and vigorous activity in (**B**).

measured with the IPAQ, with no obvious bias in the plot (Figure 2A). When walking was excluded in the MVPA calculation, there was a mean difference in MVPA of 8.88(95% CI −60.4 to 78.2) min/day, being higher when measured with the IPAQ, with a visual tendency IPAQ to overestimate MVPA at lower accelerometer-measured MVPA, and vice versa at higher accelerometer-measured MVPA (Figure 2B).

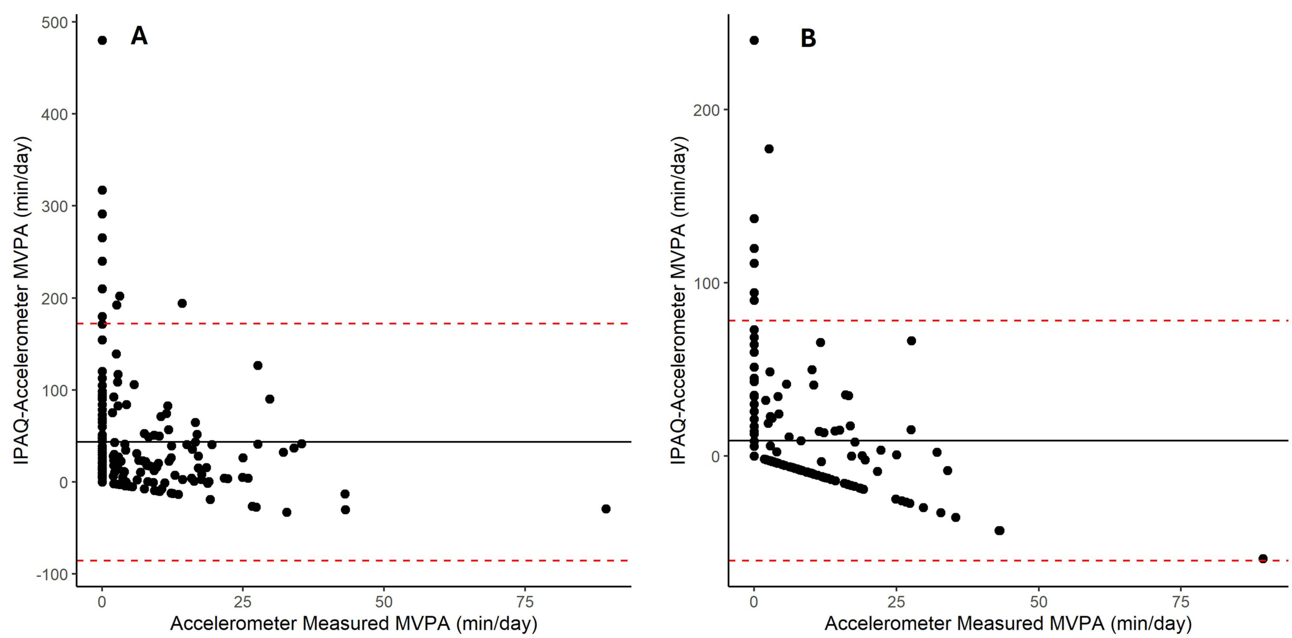

Figure 2 Bland-Altman Plot comparing MPVA measured using (**A**) the IPAQ (sum of walking, moderate and vigorous activity) and accelerometer MVPA and (**B**) the IPAQ (sum of moderate and vigorous activity) in people with type 1 diabetes. Solid line represents the mean and the red dashed lines the 95% CI.

Comparison of IPAQ with Accelerometer Derived MVPA – People with Type 2 Diabetes

The correlations between IPAQ and accelerometer-measured MVPA are shown in Figure 3. When IPAQ MVPA included walking activity a positive correlation (r = 0.23, 95% CI 0.13 to 0.33, p < 0.001) and concordance correlation (rho = 0.038, 95% CI 0.02 to 0.06), p < 0.001) was seen. When walking activity was excluded from IPAQ MVPA a positive correlation (r = 0.44, 95% CI 0.35 to 0.52, p < 0.001) and concordance correlation (rho = 0.34, 95% CI 0.27 to 0.41, p < 0.001) was seen.

The Bland-Altman plots comparing IPAQ and accelerometer-measured MVPA are shown with IPAQ MVPA including (Figure 4A) and excluding (Figure 4B) walking physical activity as MVPA. When walking was included in the MVPA calculation, there was a mean difference in MVPA of 62.3(95% CI −61.5 to 186.0) min/day, being higher when measured with the IPAQ, with no obvious bias in the plot (Figure 4A). When walking was excluded in the MVPA calculation, there was a mean difference in MVPA of 4.0(95% CI −34.1 to 42.0) min/day, being higher when measured with the IPAQ, with a visual tendency of IPA to overestimate MVPA at lower accelerometer-measured MVPA and vice versa at higher accelerometer-measured MVPA (Figure 4B).

Discussion

The current study compared self-reported (IPAQ) physical activity with accelerometer-measured MVPA in people with diabetes in Kuwait. In people with type 2 diabetes, our data demonstrated a significant correlation and concordance correlation between IPAQ and accelerometer-measured MPVA, although this was relatively weak when IPAQ MVPA including walking activity. Similarly, the mean difference in MVPA was over an hour/day when walking was included in IPAQ MVPA and was around 4 min/day when walking activity was excluded. In people with type 1 diabetes no correlation or concordance correlations were found, regardless of whether including or excluding walking activity from the MVPA calculation in the IPAQ. The mean difference was over 40 min/day when walking was included in IPAQ MVPA and was around 8 min/day when walking activity was excluded.

In the current analysis IPAQ MVPA was calculated separately including and excluding walking physical activity, which had a considerable effect on the results. In the compendium of physical activity,[24] walking activities span the light to vigorous intensity range and so its inclusion in the calculation of MVPA is controversial. For example, walking at 2

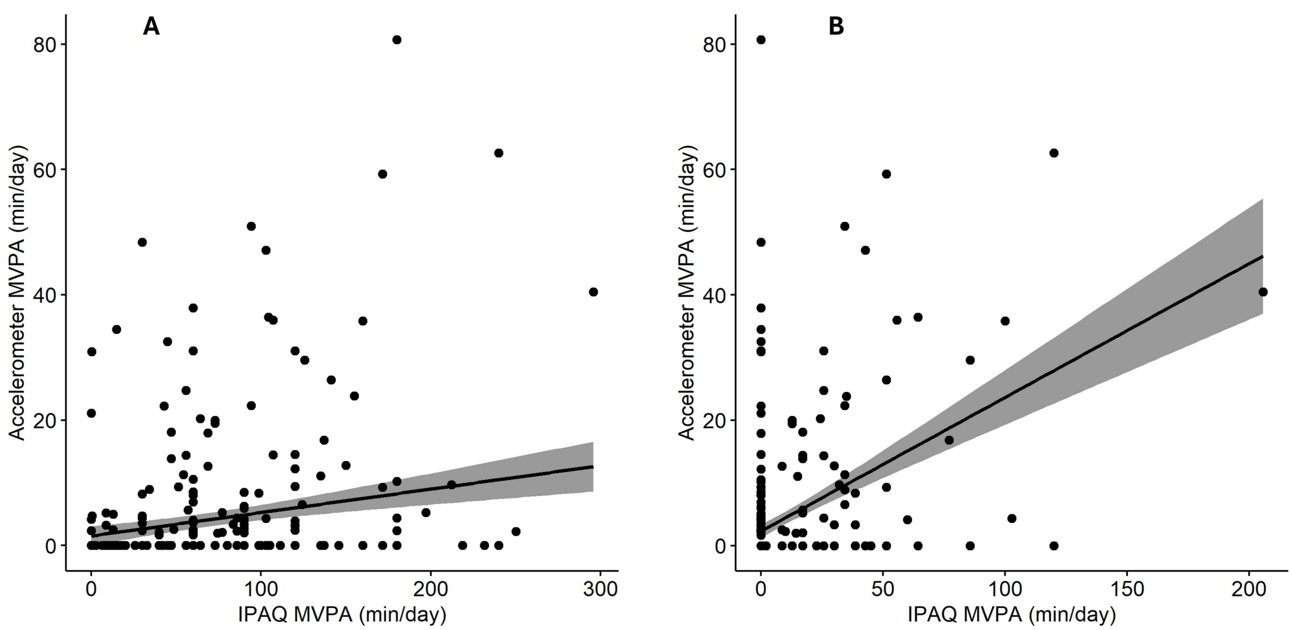

Figure 3 Correlation between MPVA measured using the IPAQ and accelerometer MVPA in people with type 2 diabetes. IPAQ MVPA includes walking, moderate and vigorous activity in (**A**) and only moderate and vigorous activity in (**B**).

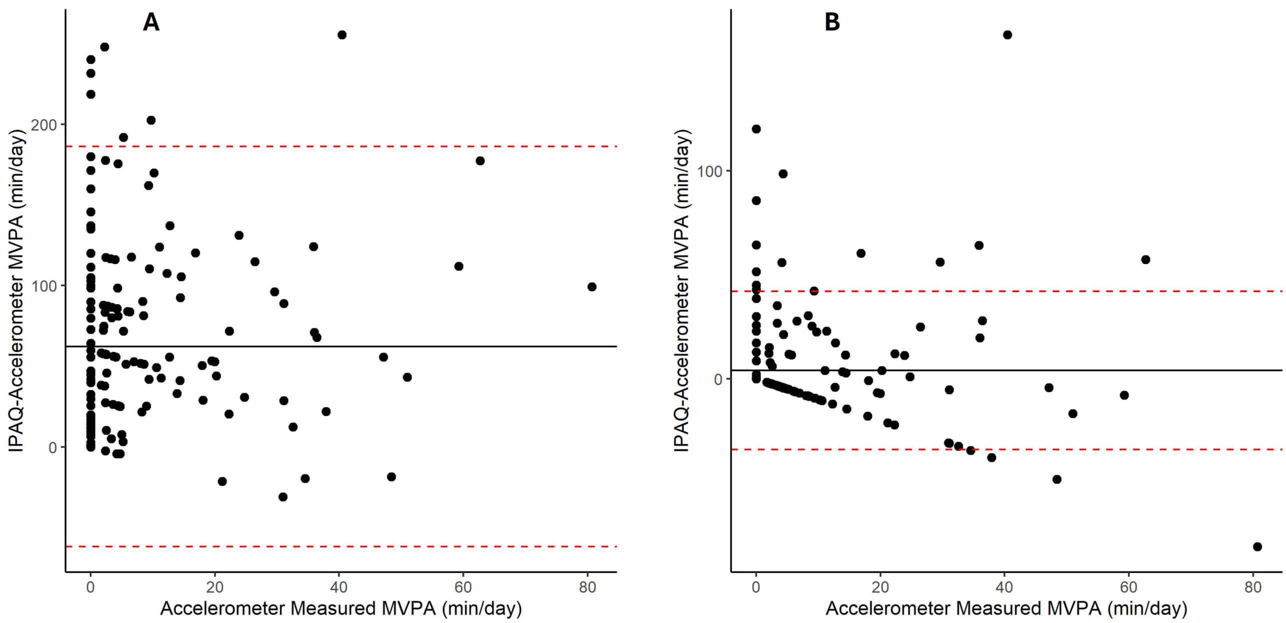

Figure 4 Bland-Altman Plot comparing MPVA measured using (**A**) the IPAQ (sum of walking, moderate and vigorous activity) and accelerometer MVPA and (**B**) the IPAQ (sum of moderate and vigorous activity) in people with type 2 diabetes. Solid line represents the mean and the red dashed lines the 95% CI.

mph on a level firm surface would be a light intensity activity, whilst walking at 3.5mph would be a moderate activity and walking at 4.5 mph would be a vigorous activity. This is of course dependent on the individual performing the physical activity. Previous work has generally included walking activity in the calculation of MVPA using the IPAQ.[17,28] One of the limitations of the IPAQ is that it does not discriminate the speed of walking but the fact that the exclusion of walking activity from MVPA resulted in a closer association to accelerometer-based MVPA indicates the participants in the current study were most likely walking at a light intensity speed. This is further supported by previous findings that the median locomotion walking speed was 2 mph in people with type 2 diabetes (age 40–70) in Canada,[29] although this is likely to be faster in our younger sample of people with type 1 diabetes. It is, of course, also possible that the accelerometer thresholds we have employed are not valid in the current populations and may misclassify physical activity intensity and explain some of the differences seen between people with type 1 and people with type 2 diabetes. Further work to establish appropriate thresholds are required in the current populations to explore this further.

Previous systematic reviews which have compared self-reported (diaries or logs; questionnaires; surveys; and recall interviews) and direct (doubly labelled water, indirect or direct calorimetry, accelerometery, pedometry, heart rate monitoring, global positioning systems, and direct observation) measures have reported mixed results with no clear trends found, with a mix of over and under reporting,[30] most likely due to the broad heterogeneity in methods and reporting of data. Some studies have compared IPAQ and accelerometer-measured MVPA, again, with mixed results. For example, Dyrstad et al,[16] in a representative sample of 11,515 adults (20–84 years), found a significant but weak correlation between moderate and vigorous physical activity measured with IPAQ vs accelerometer. Moderate intensity physical activity, in 10 min blocks (allowing 2 min of interruptions), and self-reported moderate activity (excluding walking) was 70% lower than corresponding accelerometer data. In the work of Celis-Morales et al,[17] in 317 adults (18–73 years) in Chile, comparing IPAQ with accelerometer (hip-worn) data, moderate activity (including walking) was over-reported by 55 min and vigorous activity by 8 min which is similar to the findings of the current study. Alongside our data, this indicates that the exclusion of walking from IPAQ measured MVPA may be optimal.

There is currently a paucity of physical activity data in Arabic populations, with data indicating generally low levels of activity.[15,31] The current data is important as it demonstrates that the Arabic version of the questionnaire derived from MVPA can, depending on processing, be reasonably comparable to data measured with accelerometers in people with type 2 diabetes but not in people with type 1 diabetes. This difference between people with type 1 and type 2 diabetes may be partially due to age difference in these groups, rather than the type of diabetes per se. With high levels of physical inactivity and high levels of diabetes in Arab populations, this knowledge will be important in the development, implementation and surveillance of strategies to increase MVPA.

The current study is not without limitations. We studied a sample of people with diabetes, so the findings are only generalisable to this population, and further work is needed to compare IPAQ and accelerometer-derived MVPA in the broader Arab population. We chose wrist worn accelerometers due to their ease of wear and convenience for participants, but it is worth noting that wrist worn accelerometers are generally less accurate than waist worn accelerometers.[32] As mentioned previously, the derivation of cut-points to quantify the intensity of activity specific to the current population is needed. It is also worth noting that there are also more useful data that can be generated with accelerometers that cannot be quantified with questionnaires.[33–37]

Conclusions

The current study compared self-reported (Arabic version of IPAQ) physical activity with accelerometer-measured MVPA in people with diabetes in Kuwait. We found that, when excluding walking activity from the IPAQ-derived data, there is a reasonably close relationship between IPAQ and accelerometer-measured MVPA in people with type 2, but not type 1, diabetes, although variability was high. Caution is, therefore, required when using the Arabic version of the IPAQ to measure MVPA and it may be prudent, where possible to measure MVPA with accelerometers such as for national surveillance of physical activity levels.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no completion interests in this work.

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