

A comparison of self-reported and objective physical activity measures in young Australian women

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INTRODUCTION



Why are we interested in physical activity?

- Essential for health and general wellbeing
- Positively interacts with other health behaviours
- Inadequate physical activity is linked with many chronic conditions eg obesity, diabetes, arthritis.
- Physical inactivity is the second largest contributor to the Australian burden of disease and injury
 - Women in particular face more barriers

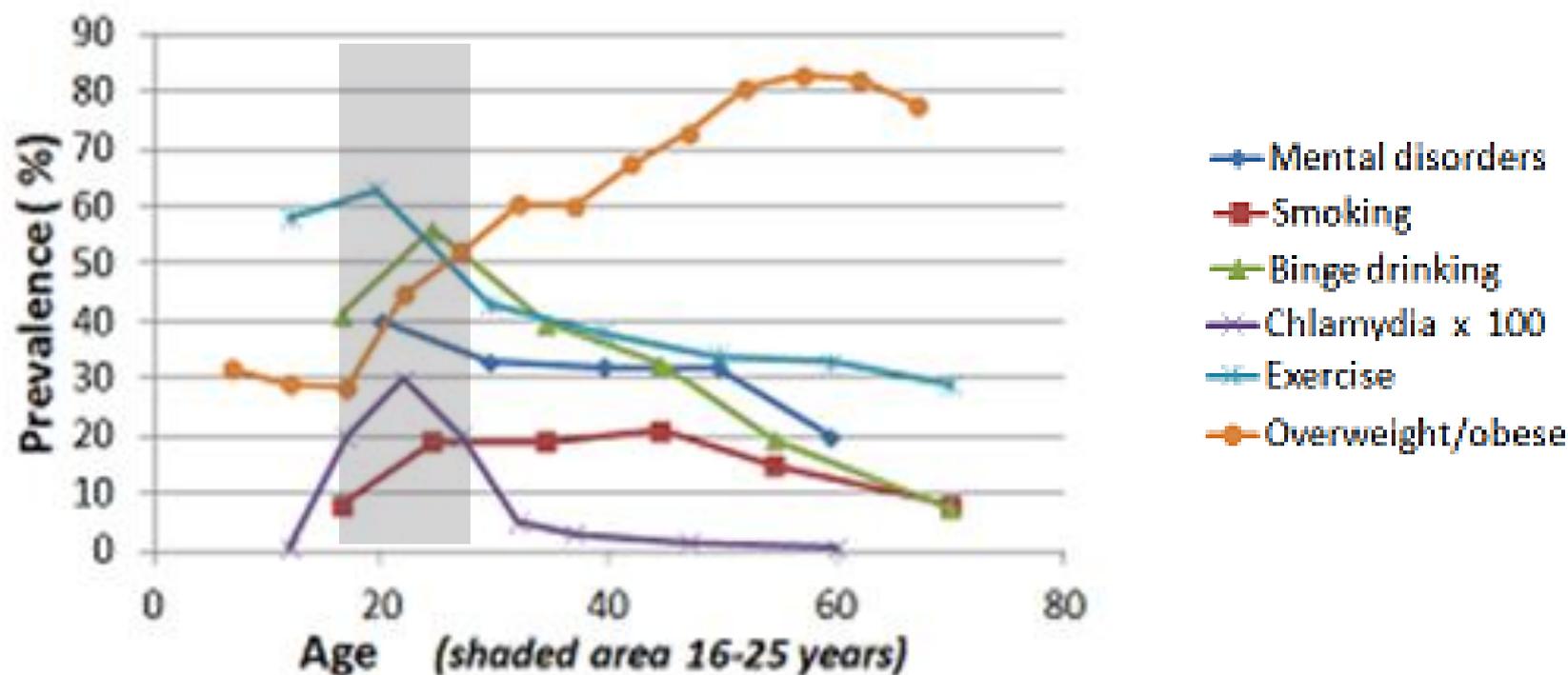


INTRODUCTION



Targeted Demographics

Trends in women's health and behaviour by age



INTRODUCTION



Challenges of measuring physical activity (interventions)

- Usually self-reported: questionnaires or diary
 - limitations: burdensome and may lead to poor compliance and bias
- A non-invasive way to objectively measure duration and intensity is desirable

GENERAL AIM



- To compare self-reported (subjective) with objectively measured physical activity levels using "SenseWear" in 18-25 years old women

Objective Measure

- SenseWear (SWA)

Subjective Measures

- International Physical Activity Questionnaire (IPAQ)
- Modified Active Australia Survey (MAAS)

OBJECTIVE MEASURE



SenseWear (SWA) - Activity Monitor

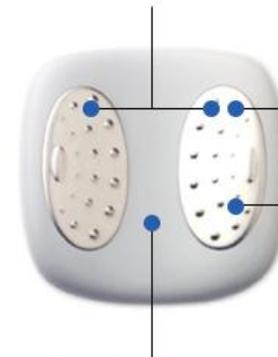
SenseWear®

- Measures:
 - (1) Skin temperature
 - (2) Heat flux
 - (3) Galvanic skin response
 - (4) Body movements
 - (5) Steps
 - (6) Sleep amount and pattern
- Well validated in other populations but not in young Australians



Galvanic Skin Response

When you sweat, your skin becomes more electrically conductive. This measurement helps to see how active you are.



Skin Temperature

Measures the surface temperature of your body.

Heat Flux

Measures the rate at which heat is dissipating from your body.

3-axis Accelerometer

Measures your motion and steps taken.



RESEARCH GOALS



1. To investigate concurrent validity of MAAS with IPAQ
2. To determine test-retest reliability of MAAS
3. To compare IPAQ and SWA
4. To test the acceptability of SWA in young Victorian women

HYPOTHESES

1. Moderate correlation between IPAQ and MAAS
2. High reliability for MAAS (*test-retest*)
3. High correlation for IPAQ and SWA
4. SenseWear will be an acceptable objective method for monitoring physical activity in young Victorian women

MAAS: Modified Active Australia Survey

IPAQ: International Physical Activity Questionnaire

SWA: SenseWear Armband

METHODS



Overview

Inclusion Criteria:

- (1) Female
- (2) 18-25 years old
- (3) Live in Victoria, Australia
- (4) Verbal and written consent
- (5) Complete the study procedures

Withdrawn participants:

- (1) Develop discomfort with the armband
- (2) Unable to complete the study

Study Procedures:

70 Victorian women 18-25 years old cross recruited from previous studies and YFHI website (<https://yfhi.org/>)

Complete online baseline physical activity questionnaire (MAAS and IPAQ)

Wear SenseWear (SWA) monitor for 1 week

Complete identical follow-up physical activity questionnaire (MAAS and IPAQ)



Data Analysis

Continuous Variables:

Metabolic equivalent scores ($\text{MET} \cdot \text{min} \cdot \text{week}^{-1}$)
= specific METs estimate * total minutes in a week

1 MET = resting energy expenditure

Categorical Variables:

Low, Moderate or High based on the total continuous scores

MAAS and IPAQ have different calculation of METs estimates and categorical criteria.

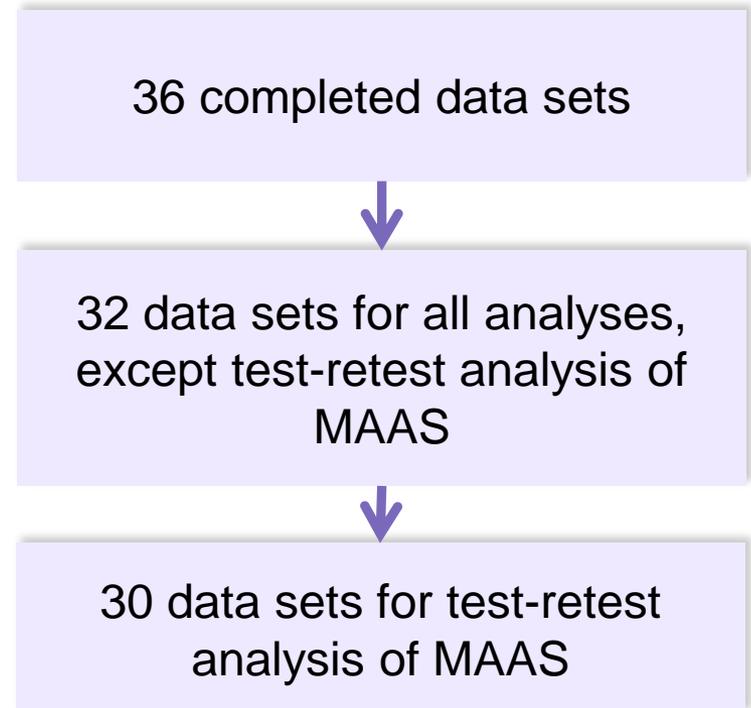
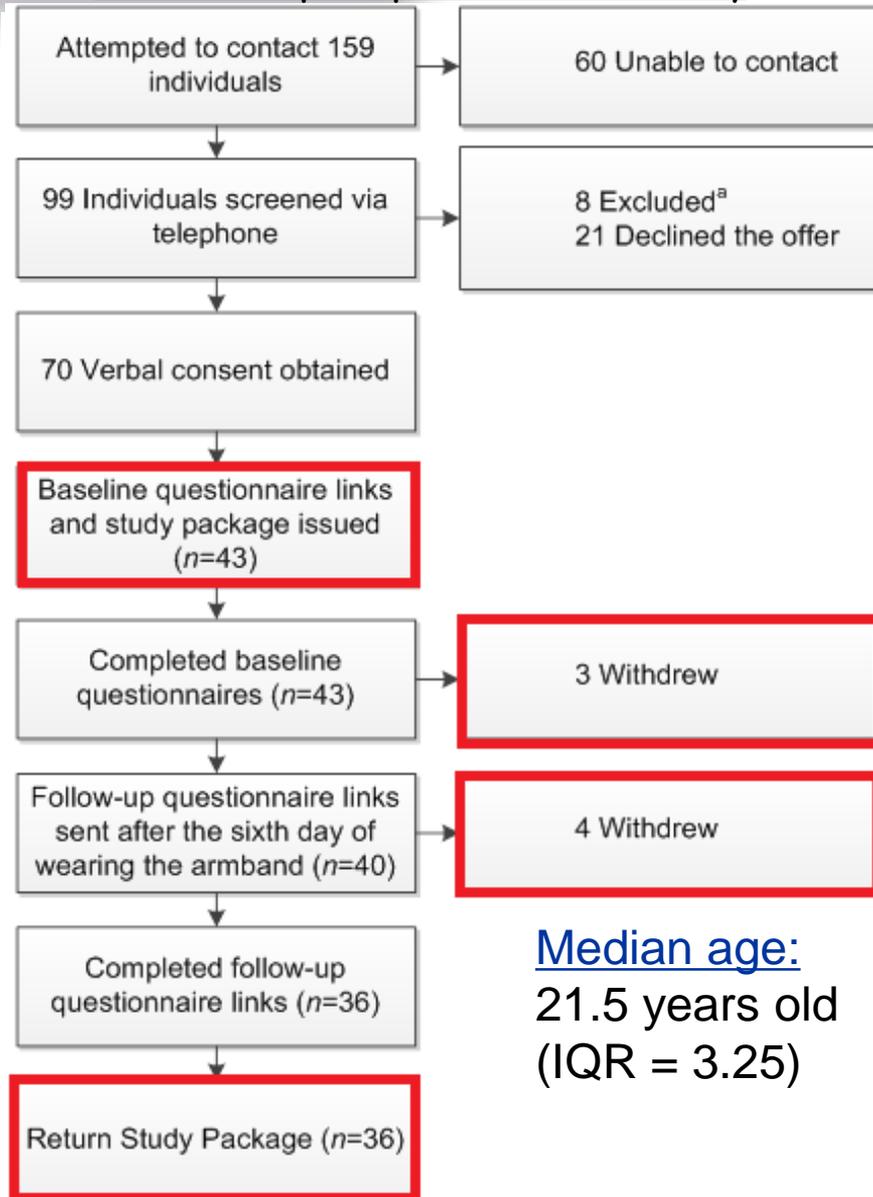
IPAQ METs values and criteria were applied to SWA data

RESULTS

Participants



Flow chart of participants at different study



Median age:
21.5 years old
(IQR = 3.25)

Median Weight:
62.5 kg
(IQR = 14)

Median Height:
165 cm
(IQR = 8.5)

Physical Activity Study : Overview & Instructions

What's Involved?

There are three components to this study:

(1) Complete a baseline physical activity survey online before wearing the armband. An email with the link to the baseline physical activity survey has been sent to you.

(2) Wear the enclosed armband for a period of 7 days. Please refer to the instructions (below) on how to correctly wear the device.

Only remove the armband whilst undertaking activities where the monitor is at risk of getting wet, e.g. showering or swimming. You will need to record the times that you take off and put on the monitor in the Physical Activity Monitor Log.

(3) Complete a follow-up physical activity survey online after the 7 days. An email with the link to the follow-up physical activity survey will be sent 6 days after the completion of the baseline physical survey.

Wearing the Monitor

Please wear the Armband on the back of the upper left arm (the triceps), as shown in the picture below. To work properly, the Armband logo must face upwards towards the shoulder and the silver sensors on the underside of the Armband will be in contact with your skin.

1. Be sure the upper left arm is clean, dry and free of lotion or oil, then slide the Armband onto your left arm.
2. Adjust the strap so that it fits comfortably, and then secure the Velcro pull-tab. Ensure that the sensors on the underside on the Armband maintain continuous contact with your skin and that the Armband does not slide off your arm.
3. Do not secure the strap too tightly. You should be able to place two fingers beneath the strap. Once the strap is adjusted to a comfortable fit, there is no need to readjust the Velcro tab. Simply slide the Armband on and off your arm by stretching the strap.
4. Within the first 10 minutes of wearing the monitor or taking it off, the monitor will beep to indicate the commencement and end of a data collection period.
5. Wear the Armband no more than 23 hours a day. Be sure to leave it off 1 hour per day.





YFHI – Physical activity Monitor Usage Log

ID No: _____ Name: _____

When did you start wearing the monitor? Date: ____/____/____ Time ____:____ AM / PM

Sometimes you will have to remove the activity monitor:

You will need to remove the activity monitor when undertaking activities where the monitor is at risk of getting wet. If you take the monitor off during the day (for example when you go swimming or take a shower), please write down when you take the monitor off, when you put it back on and the reason why you took it off.

	Time monitor taken off	Time monitor put back on	Why did you remove the activity monitor? <i>e.g. swimming, showering, other water sports</i>	Level of physical activity while monitor off body*		
				<i>Please tick the appropriate box.</i>		
				None/Light	Moderate	Vigorous
<i>Example</i>	<i>12:45 AM/PM</i>	<i>1:30 AM/PM</i>	<i>Swimming</i>		✓	
Day 1	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				
Day 2	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				
Day 3	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				
Day 4	: AM/PM	: AM/PM				
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Day 5	: AM/PM	: AM/PM				
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Day 6	: AM/PM	: AM/PM				
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	: AM/PM	: AM/PM				
Day 7	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				
	: AM/PM	: AM/PM				

*None/light: no change in normal breathing, e.g. showering

1. The monitor has been designed to be easy to wear. However, in a small number of individuals (<1%), skin irritation may occur as a result of wearing the device. If severe skin irritation occurs, remove the monitor and consult a doctor. Let the study team know if you experience any significant irritation from wearing the monitor (email: contact@yfhi.org; phone: 1800 188 385).

⚠ **Be careful not to over-tighten the strap while on your arm. If you feel constriction or loss of circulation at any time, loosen the adjustable strap and re-fasten it to a more comfortable setting.**

Caring for the Monitor

- ⚠ Please handle it with care. Though the Armband was designed for wearability and long-term use, it is a sensitive monitoring device. Rough handling can break internal components. Never drop or shock the Armband and always store it in a safe place when not in use.
- ⚠ Avoid touching the silver sensors on the underside of the armband. These sensors should only make contact with your arm during use.
- ⚠ Avoid exposing the equipment to extreme temperatures, direct sunlight, moisture, sand, dust or mechanical shock.
- ⚠ **DO NOT IMMERSE THE ARMBAND IN WATER.** The Armband is not designed to be used underwater or to come in continuous contact with water.

The activity monitor is not waterproof, therefore you'll need to remove the monitor when undertaking activities where the monitor is at risk of getting wet, e.g. showering or swimming. Please re-attach the monitor as soon as you can and record these periods using the activity log provided.

Clean the Armband daily after sweating or when it becomes noticeably moist or dirty. Failure to keep the Armband clean, or improper cleaning, may irritate the skin and affect the sensor performance.

- a) Gently wipe the side of the monitor with the silver sensors with a soft moistened cloth.
- b) Use a dry, soft cloth to completely dry the monitor before wearing it.

Returning the Monitor

At the end of the 7 days, kindly return the [Bodymedia SenseWear](#) monitor along with one copy of the signed [Participant Information and Consent Form](#) and the [Physical Activity Monitor Log](#), using the box and bubble wrap the monitor arrived with. A prepaid Registered Post label (supplied) needs to be attached to the box (best placed on top of the pre-existing label on the top left corner), along with the Reply Paid label, which goes over your mailing details (please see diagram on left). The box needs to be lodged over the counter at a Post Office, with the accompanying Registered Post lodgement receipt. Fasten the box with sticky tape and rubber bands as the box was provided to you. **Please do not post the package in street posting boxes as they do not have proof of posting.**



Please attach Registered Post and Postage Paid Labels before taking to Post Office

Please return the monitor as soon as you have completed the 7 days.

RESULTS



Follow-up IPAQ vs. Follow-up MAAS (n=32)

Categorical outcomes:

Cross Tabulation of categorical outcomes from MAAS and IPAQ follow-up questionnaires

		IPAQ (Followup)			Total
		Low	Moderate	High	
MAAS (Follow up)	Low	Count 7 % within IPAQ (Followup) 53.80%	Count 1 % within IPAQ (Followup) 16.70%	Count 0 % within IPAQ (Followup) 0.00%	Count 8 % within IPAQ (Followup) 25.00%
	Moderate	Count 3 % within IPAQ (Followup) 23.10%	Count 2 % within IPAQ (Followup) 33.30%	Count 5 % within IPAQ (Followup) 38.50%	Count 10 % within IPAQ (Followup) 31.30%
	High	Count 3 % within IPAQ (Followup) 23.10%	Count 3 % within IPAQ (Followup) 50.00%	Count 8 % within IPAQ (Followup) 61.50%	Count 14 % within IPAQ (Followup) 43.80%
Total		Count 13 % within IPAQ (Followup) 100.00%	Count 6 % within IPAQ (Followup) 100.00%	Count 13 % within IPAQ (Followup) 100.00%	Count 32 % within IPAQ (Followup) 100.00%

- 17 of the 32 cases (**53%**) were in agreement
- $\kappa = 0.29, p = 0.016$
- κ - kappa coefficient

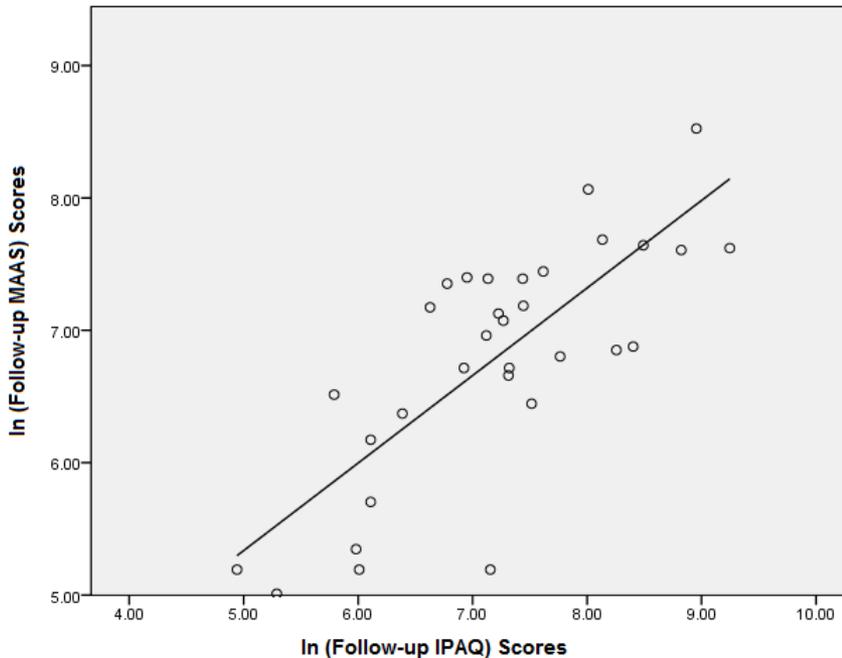
RESULTS



Follow-up IPAQ vs. Follow-up MAAS ($n=32$)

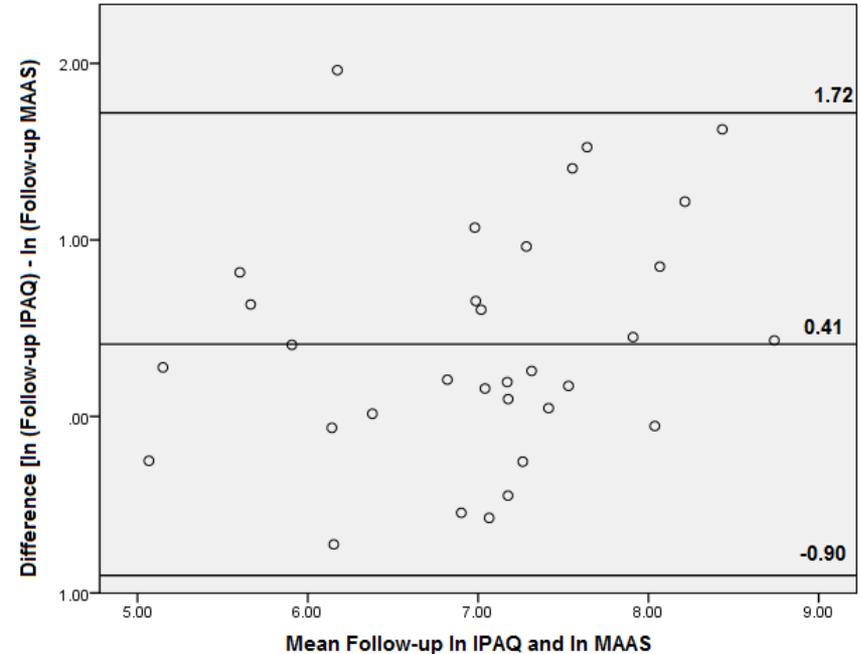
Continuous outcomes:

Scatter plot of follow up questionnaires of both In IPAQ and In MAAS Scores



$$r = 0.77, p < 0.0001$$

Bland-Altman Plot of natural log transformed score showing the difference between follow-up IPAQ and MAAS, plotted against the mean



Mean difference of 1.51 (ln 0.41)
 $r = 0.24, p = 0.19$



Test-retest reliability of MAAS (Baseline MAAS vs. Follow-up MAAS) ($n=30$)

Categorical outcomes:

Cross tabulation of MAAS follow-up and baseline categorical levels

		MAAS (Baseline)			Total
		Low	Moderate	High	
MAAS (Followup)	Low	Count 3 % within MAAS (Baseline) 50.00%	Count 1 % within MAAS (Baseline) 20.00%	Count 3 % within MAAS (Baseline) 15.80%	7 23.30%
	Moderate	Count 1 % within MAAS (Baseline) 16.70%	Count 2 % within MAAS (Baseline) 40.00%	Count 7 % within MAAS (Baseline) 36.80%	10 33.30%
	High	Count 2 % within MAAS (Baseline) 33.30%	Count 2 % within MAAS (Baseline) 40.00%	Count 9 % within MAAS (Baseline) 47.40%	13 43.30%
Total		Count 6 % within MAAS (Baseline) 100.00%	Count 5 % within MAAS (Baseline) 100.00%	Count 19 % within MAAS (Baseline) 100.00%	30 100.00%

- Median interval = 11.5 days (7-32 days)
- 14 of the 30 cases (**47%**) were in agreement
- Intraclass correlation (ICC) = 0.44, 95% CI = 0.10-0.69, $p = 0.007$
- $\kappa = 0.14$, $p = 0.24$

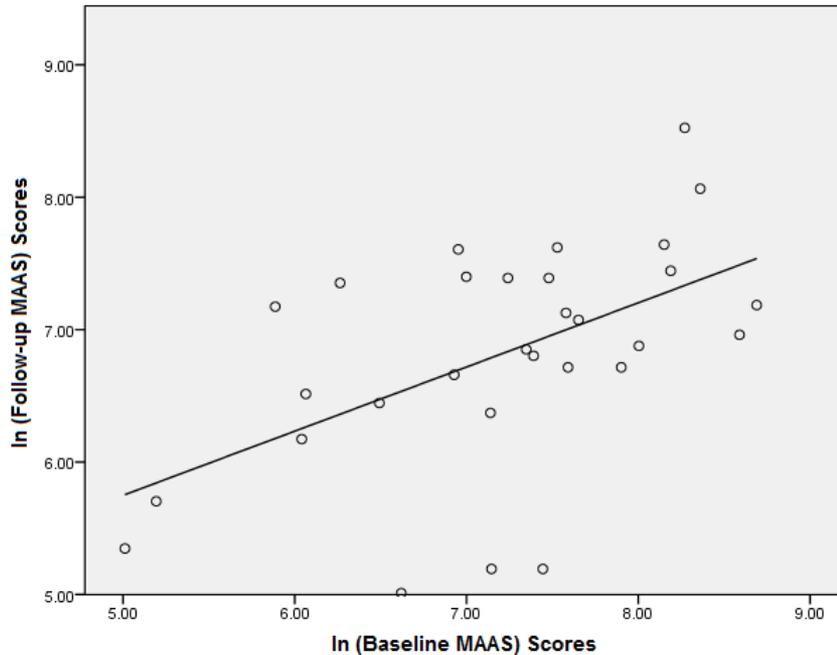
RESULTS



Test-retest reliability of MAAS (Baseline MAAS vs. Follow-up MAAS) ($n=30$)

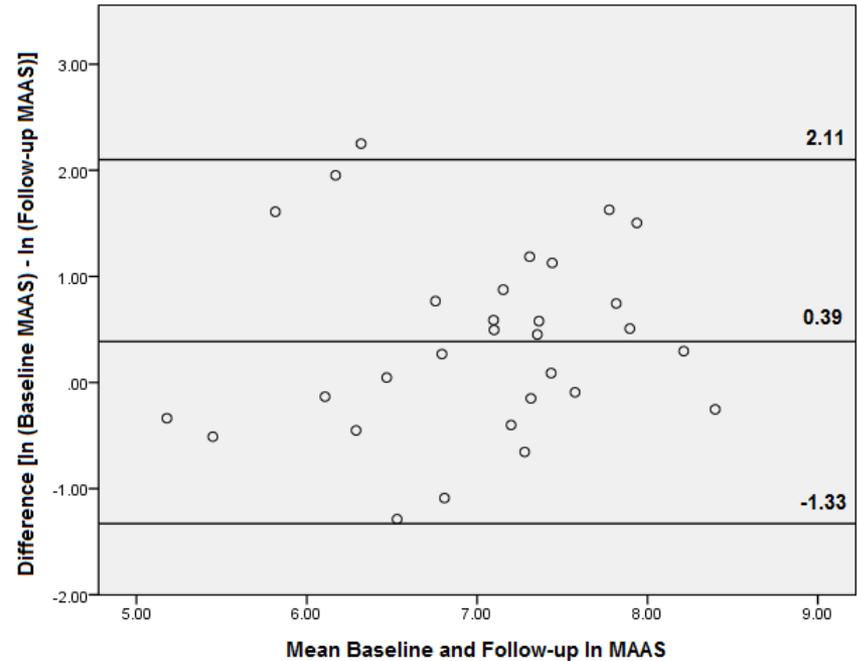
Categorical outcomes:

Scatterplot of baseline and follow-up In MAAS scores



$r = 0.53, p = 0.003$

Bland-Altman Plot of natural log transformed score showing the difference between baseline MAAS and follow-up MAAS, plotted against the mean



Mean difference of 1.48 (ln 0.39)
 $r = 0.02, p = 0.91$

RESULTS

IPAQ vs. SWA ($n=32$)

SWA

- (1) Minute-by-minute Data questionnaire
- (2) Blocked Data

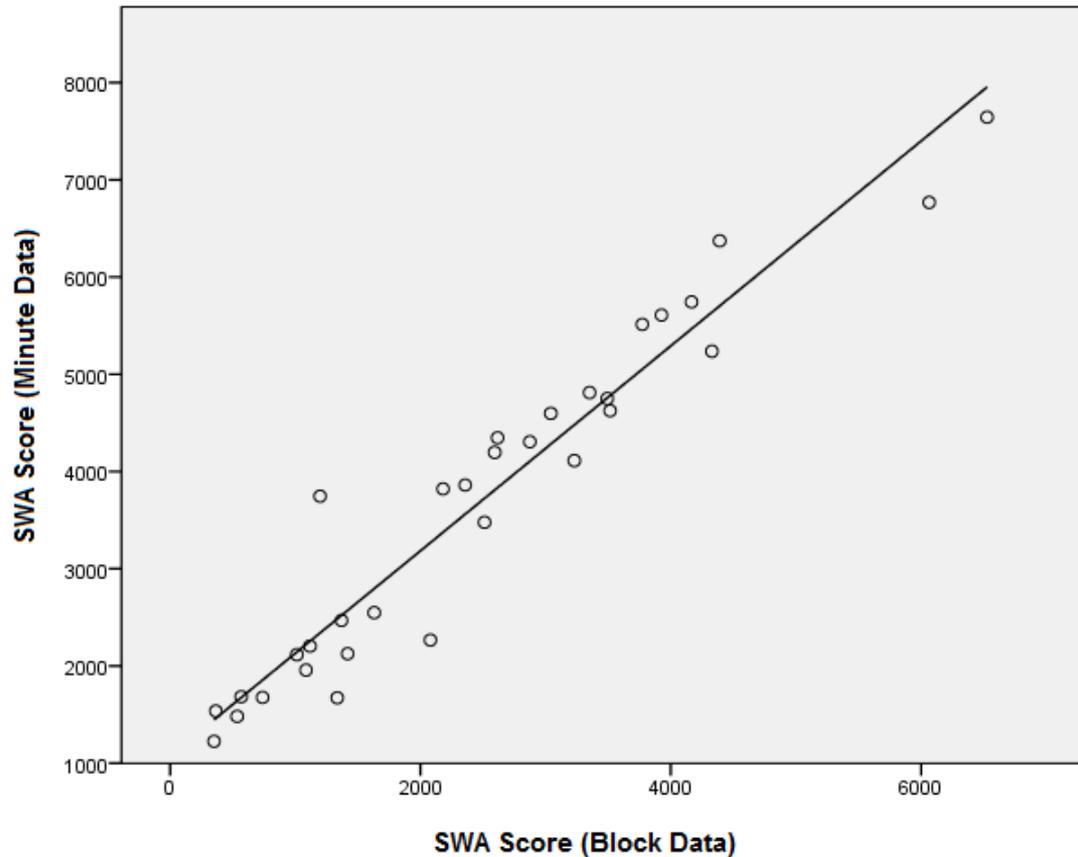
IPAQ

From follow-up

Categorical outcomes:

- Block $\chi = -0.07$
- Minute $\chi = -0.02$

Scatterplot of Minute-by-minute and Block activities continuous scores obtained from SenseWear armband ($n = 32$)



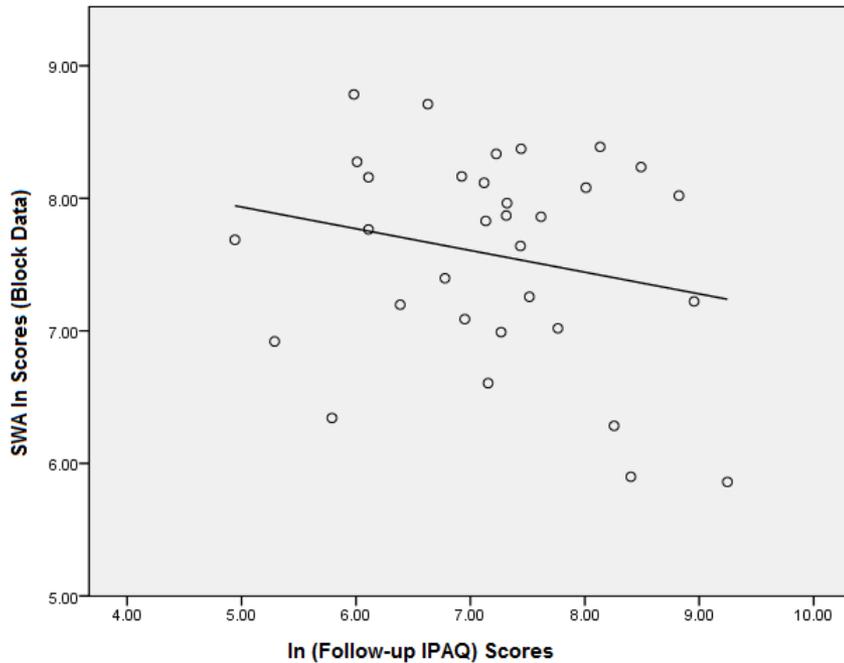
($r = 0.963$, $n = 32$, $p < 0.0001$).

RESULTS

IPAQ vs. SWA ($n=32$)

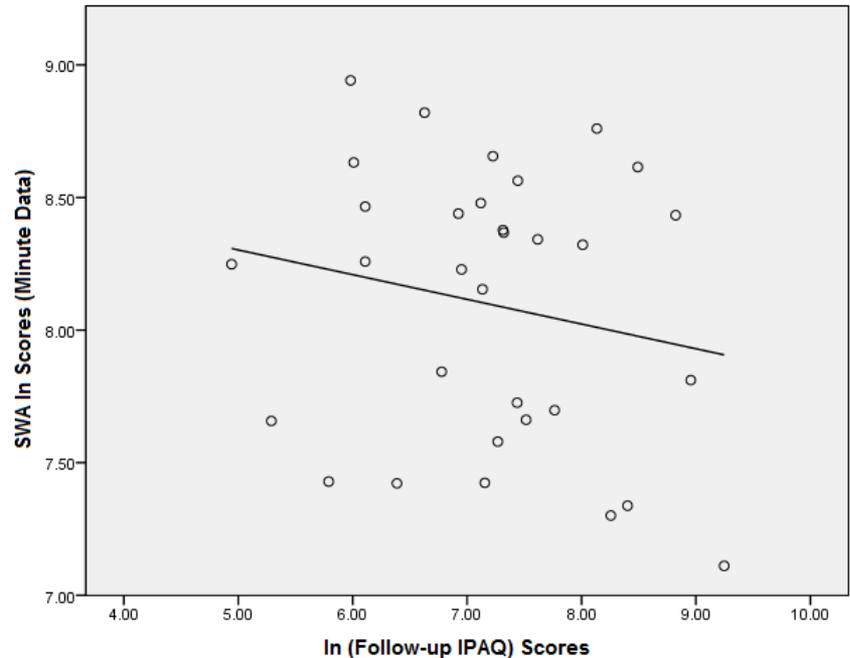
Continuous outcomes:

Scatterplot of SWA In block scores and follow-up In IPAQ scores



$$r_b = -0.22, p = 0.230$$

Scatterplot of SWA in minute scores and follow-up In IPAQ scores



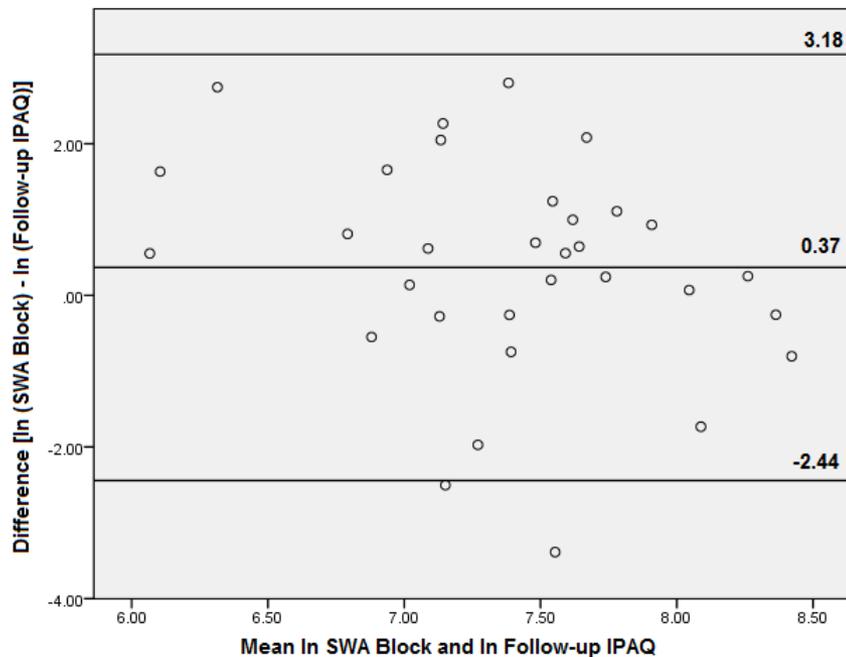
$$r_{min} = -0.19, p = 0.301$$

RESULTS

IPAQ vs. SWA ($n=32$)

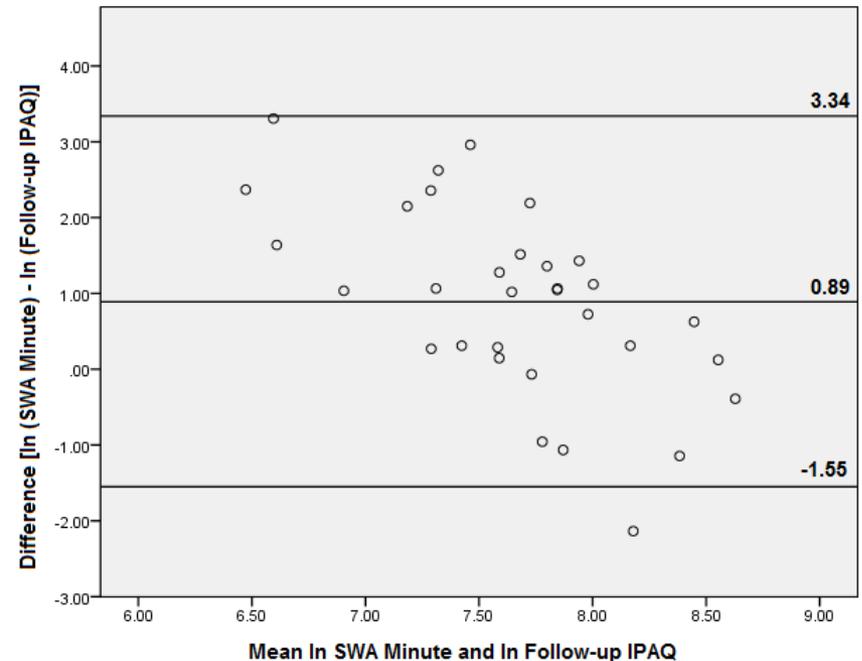
Continuous outcomes:

Bland-Altman Plot of natural log transformed score ($\text{MET}\cdot\text{min}\cdot\text{week}^{-1}$) showing the difference between SWA block and follow-up IPAQ, plotted against the mean



Mean difference of 1.45 (ln 0.37)
 $r = -0.29, p < 0.0001$

Bland-Altman Plot of natural log transformed score ($\text{MET}\cdot\text{min}\cdot\text{week}^{-1}$) showing the difference between SWA minute and follow-up IPAQ, plotted against the mean



Mean difference of 2.39 (ln 0.87)
 $r = -0.62, p = 0$



Acceptability of SWA ($n=36$)

Participants' experience of wearing the SenseWear armband

Agreement to the following 3 out of 12 statements:	Scale from 1="completely false" to 5="complete true					Median
	% (n)					
	1	2	3	4	5	
"I exercised more than I otherwise would have, because of wearing the activity monitor"	66.7% (24)	22.2% (8)	5.6% (2)	2.8% (1)	2.8% (1)	1
"I would prefer to record my physical activity for the last 7 days by completing a survey rather than wearing the activity monitor for 7 days"	63.9% (23)	13.9% (5)	13.9% (5)	2.8% (1)	5.6% (2)	1
"I would like to wear the activity monitor everyday if I could get real-time feedback of my physical activity and calories burned"	11.1% (4)	5.6% (2)	30.6% (11)	22.2% (8)	30.6% (11)	4

Compliance of **(83.7%)** (36 of 43)

Summary



1. MAAS and IPAQ (Follow-up questionnaires)

- Significant strong correlation between the subjective measures

2. MAAS Retest

- A significant, moderate positive linear correlation for overall minutes of activities
- However no significant agreement was seen between the categorical outcomes
- Consistent with other study ¹

3. Follow-up IPAQ and SWA

- Poor agreement was seen between subjective and objective measures
- A significant strong negative linear correlation was observed for SWA minute and IPAQ

4. Acceptability of SWA

- Good acceptability as a high compliance was attained
- Majority of participants preferred wearing the SWA for 7 days over self-reporting their physical activity levels.

¹ Brown, W.J., et al., *Reliability and validity of a modified self-administered version of the Active Australia physical activity survey in a sample of mid-age women*. Australian and New Zealand journal of public health, 2008. **32**(6): p. 535-541.

Strengths and Future Directions



- First study that investigated the use of SWA and tested the correlation between it with IPAQ and MAAS in young Australian women
- Informative for future studies about which measures could be used in young Australian women
- Larger sample of young women and longer observation term with SWA (performed 65)

CONCLUSION



- Findings from this study do not support the use of one assessment tool for physical activity over another.
- Suggest the use of both subjective and objective assessment tool.
- Suggest incorporating SWA in future studies



Pedometers:

Pedometers count steps – but most of us only spend about 3% of our day walking.

Accelerometers:

Accelerometers measure movement – but not the calories burned when we're lifting weights, watching TV or sleeping.

Heart Rate Monitors:-

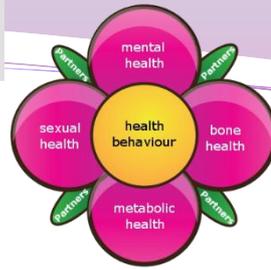
Heart rate monitors measure calories burned while we're physically active – but what about the rest of the time?

SWA

- Not water resistant
- Expensive

	BodyMedia FIT	Accelerometers	Pedometers	Heart Rate Monitors
Captures 5,000+ readings every minute for 90% calorie accuracy	✓			
Gathers data all day and night	✓	✓		
Provides information of calories burned, calories consumed and sleep	✓	✓		
Measures calorie burn while you exercise and run	✓	✓	✓	✓
Mobile Food Logging	✓			
Near real-time view of your stats on your Smartphone or Display	✓			

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