
Actigraphic Monitoring of Heart Rate and Movement
as an Index of Daily Body Energy Expenditure
in Health and Disease

By

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Dedication

This work is dedicated to my dear wife (Iman Al-owaidi), lovely son (Youssif) and my sweetheart girl (Ayah), for their love, support, help and encouragement to pursue overseas study.

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Abstract

The studies in this thesis were prompted by the rapidly emerging field of actigraphy which can provide nonintrusive measurements of physical activity over prolonged periods in free-living conditions. These features offer a unique opportunity to investigate daily activities and how such activities can be impaired by clinical disorders. A series of investigations were carried out to evaluate the accuracy of actigraphic based estimates of body energy expenditure made with an Actiheart system at rest and during exercise in healthy individuals (Studies 1 and 2 described in Chapters 2 and 3). A subsequent study (Study 3 described in Chapter 4) examined Actiheart based measurements of daily body energy expenditure in obstructive sleep apnoea (OSA) patients, how body energy expenditure varied throughout the day in these patients, and whether daily body energy expenditure and the daily body energy expenditure profile changed after commencement of nightly treatment with continuous positive airway pressure (CPAP). A central hypothesis in the OSA study (Study 3 described in Chapter 4) was that reversal of excessive daytime sleepiness by CPAP would result in increased daily activities and increased body energy expenditure. As shown in Study 2, the Actiheart system provided accurate estimates of body energy expenditure in healthy men under resting conditions and during mild and moderate levels of 3 types of exercise (arm ergometry, bicycle ergometry and treadmill walking) performed at matched workloads. This study is the first to demonstrate that the accuracy of Actiheart based BEE estimates at matched mechanical workloads remains high over a range of different modes of exercises which involved different body movements utilising different muscle groups. As predicted, the heart rate response to arm exercise was higher than during bicycle and treadmill exercise at matched workloads. However, this did not impair the Actiheart's ability to provide accurate estimates of body energy expenditure. The findings of the OSA study (Study 3) suggested that these patients

had a sedentary lifestyle, and that nightly CPAP therapy increased daily activities and daily body energy expenditure as a result of reduced daytime sleepiness. Of particular interest, after 4-6 weeks of nightly CPAP therapy the OSA participants spent 2.04 hours less time per day ($p \leq 0.05$) sleeping and engaged in activities where the metabolic rate was 0-1.99 metabolic equivalents above the basal metabolic rate. Thus, the studies in this thesis have contributed to the body of evidence demonstrating that the Actiheart system can be a useful tool for accurately and objectively assessing daily activities in healthy individuals and when daily activities are impaired by clinical disorders.

Declaration

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.



Amged Mehdi

Conference Presentations and Abstracts

A Mehdi and T Van der Touw. Actiheart based estimate of body expenditure are accurate during treadmill walking, arm ergometry and bicycle ergometry. 4th International congress on physical activity and public health. Convention and Exhibition Centre, Sydney, Australia. 31 October - 3 November 2012. Oral presentation.

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Abbreviations

ActEE	Activity energy expenditure
AEE	physical activity energy expenditure
BEE	body energy expenditure
BMI	Body mass index
CO ₂	Carbon dioxide
COPD	Chronic Obstructive Pulmonary Disease
CPAP	Continuous positive airway pressure
CPAP-1	1-2 weeks after the commencement of nightly CPAP treatment
CPAP-2	4-6 weeks after the commencement of nightly CPAP treatment
Cpm	Counts per minute
ECG	Electrocardiogram
ESS	Epworth Sleepiness Scale
FOSQ	Functional Outcomes of Sleep Questionnaire
HREE	Heart rate energy expenditure
KJ/min ⁻¹	Kilo Joule per minute
O ₂	Oxygen
OSA	Obstructive sleep apnoea
Pre-CPAP	1-2 weeks prior to the commencement of nightly CPAP treatment
RER	Respiratory exchange ratio
SD	Standard deviation
V	Intercostal
VCO ₂	Rate of carbon dioxide production

V_{O_2} Oxygen consumption

List of Figures

Figure 1-1: The Omron HJ- 112 pedometer	3
Figure 1-2: A illustration of an wrist mounted Actiwatch (Cambridge Neurotechnology)	5
Figure 1-3: The differences in measurement between differing activity monitors and the variation in resulting energy expenditure (top- 32 year old male-walk, cycle and then walk for 40 minutes each; bottom -34 year old male-brisk walking 25 minutes, then 15 minutes of running, 30 minutes playing tennis, and 50 minutes carrying books and papers.....	8
Figure 1-4: The relationship between accelerometer activity counts (positioned on the back and the hip) and body energy expenditure measured in metabolic equivalents (METs) by indirect calorimetry during treadmill walking and running.....	9
Figure 1-5: Mean difference in energy expenditure between 4 different accelerometer motion sensors and indirect calorimetry during 3 levels of exercise intensity. A negative value indicates underestimation and a positive value indicates overestimation. * $p < 0.05$ and # $p < 0.001$	12
Figure 1-6: Linear regression between VO_2 and HR during exercise workloads.....	12
Figure 1-7: Activity energy expenditure (AEE) measured by indirect calorimetry with a Cosmed K4b ² system and simultaneously estimated with an Actiheart system during 18 different daily activities...14	
Figure 1-8: Actiheart system correctly placed on a participant to avoid vertical distortion in movement.....	15
Figure 1-9: The Jaeger Oxycon Mobile system which provides telemetric indirect calorimetric measurements of oxygen consumption.....	16
Figure 1-10: Simultaneous room calorimeter measurements (measured EE) and Actiheart based estimates (predicted EE) of body energy expenditure during various activities throughout an entire 24 hour period.....	17
Figure 1-11: The base line activity status and health benefit dose response curve.....	22

Figure 1-12: Number of yearly publications focusing on actigraphy and sleep.....	30
Figure 2-1: The author wearing the Oxycon Mobile system and holding the Actiheart system in his left hand. Note the difference in size and bulkiness of these two pieces of equipment.....	45
Figure 2-2: flow chart modified from (Brage et al., 2007) equation.....	50
Figure 2-3: Relationship between actigraphic estimates of body energy expenditure (BEE) and BEE measured by indirect calorimetry (Oxycon Mobile) during rest (sitting and standing) and during treadmill walking at 3, 5 and 7 km/hr in 6 participants. Only the third minute of data for each resting and walking condition was used. Linear regression and correlation statistics did not specify that the regression line must pass through the origin (0.0).....	55
Figure 2-4: Relationship between actigraphic estimates of body energy expenditure (BEE) and BEE measured by indirect calorimetry (Oxycon Mobile) during rest (sitting and standing) and during treadmill walking at 3, 5 and 7 km/hr in 6 participants. Only the third minute of data for each resting and walking condition was used. Linear regression and correlation statistics specified that the regression line must pass through the origin (0.0).....	55
Figure 2-5: Relationship between actigraphic estimates of body energy expenditure (BEE) and BEE measured by indirect calorimetry (Oxycon Mobile) during rest (sitting and standing) and during treadmill walking at 3, 5 and 7 km/hr in one participant (M 4). Only the third minute of data for each resting and walking condition was used. Linear regression and correlation statistics specified that the regression line must pass through the origin (0.0).....	56
Figure 2-6: Relationship between actigraphic estimates of body energy expenditure (BEE) and BEE measured by indirect calorimetry (Oxycon Mobile) during rest (sitting and standing) and during treadmill walking at 3, 5 and 7 km/hr in one participant (M 5). Only the third minute of data for each resting and walking condition was used. Linear regression and correlation statistics did not specify that the regression line must pass through the origin (0.0).....	56
Figure 3-1: Indirect calorimetric measurements of body energy expenditure made with the Oxycon mobile system during three different exercise modes at four different levels of exercise intensity. Data are means \pm 1 SD (horizontal bars) from 10 healthy men Lowest exercise intensity – 3 km.hr ⁻¹ (treadmill) and 150 kpm.min ⁻¹ (ergometers). Intermediate exercise intensity – 5 km.hr ⁻¹ (treadmill) and 300 kpm.min ⁻¹ (ergometers). Highest exercise intensity – 7 km.hr ⁻¹ (treadmill) and 600 kpm.min ⁻¹ (ergometers).....	71
Figure 3-2: Estimated body energy expenditure from the Actiheart system during three different exercise modes at four different levels of exercise intensity. Data are means \pm 1 SD (horizontal bars) from 10 healthy men Lowest exercise intensity – 3 km.hr ⁻¹ (treadmill) and 150 kpm.min ⁻¹ (ergometers). Intermediate exercise intensity – 5 km.hr ⁻¹ (treadmill) and 300 kpm.min ⁻¹ (ergometers). Highest exercise intensity – 7 km.hr ⁻¹ (treadmill) and 600 kpm.min ⁻¹ (ergometers).....	73

Figure 3-3: Heart rate t during three different exercise modes at rest and three different levels of exercise intensity. Data are means \pm 1 SD (horizontal bars) from 10 healthy men. Lowest exercise intensity – 3 km.hr⁻¹ (treadmill) and 150 kpm.min⁻¹ (ergometers). Intermediate exercise intensity – 5 km.hr⁻¹ (treadmill) and 300 kpm.min⁻¹ (ergometers). Highest exercise intensity – 7 km.hr⁻¹ (treadmill) and 600 kpm.min⁻¹ (ergometers).....75

Figure 3-4: Relationship between Actiheart based estimates of BEE and simultaneous indirect calorimetric measurements of BEE (Oxycon Mobile) during rest (sitting) and during treadmill walking at 3, 5 and 7 km/hr⁻¹. Data are means from in 10 healthy men. The diagonal line represents the line of identity. Note the very close agreement between mean Actiheart based and indirect calorimetric measurements of BEE.....76

Figure 3-5: Relationship between Actiheart based estimates of BEE and simultaneous indirect calorimetric measurements of BEE (Oxycon Mobile) during rest (sitting) and during arm ergometric exercise at 150, 300 and 600 kpm/min⁻¹. Data are means from in 10 healthy men. The diagonal line represents the line of identity. Note the very close agreement between mean Actiheart based and indirect calorimetric measurements of BEE.....77

Figure 3-6: Relationship between Actiheart based estimates of BEE and simultaneous indirect calorimetric measurements of BEE (Oxycon Mobile) during rest (sitting) and during bicycle ergometric exercise at 150, 300 and 600 kpm/min⁻¹. Data are means from in 10 healthy men. The diagonal line represents the line of identity. Note the very close agreement between mean Actiheart based and indirect calorimetric measurements of BEE.....78

Figure 4-1: Daily AEE (kJ/day⁻¹) measurements at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA.....101

Figure 4-2: ESS at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA..101

Figure 4-3: FOSQ-30 at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA.....102

Figure 4-4: FOSQ-Activity at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA.....102

Figure 4-5: FOSQ-Vigilance at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA.....103

Figure 4-6: FOSQ-Intimacy at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA.....103

Figure 4-7: FOSQ-General productivity at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA.....104

Figure 4-8: FOSQ-Social outcome at Pre-CPAP, CPAP-1 and CPAP-2. Data are means \pm SD for 12 men with OSA.....104

Figure 4-9: Percentage of total time spent at different levels of AEE over the three 1 week actigraphic recording periods (Pre-CPAP, CPAP-1 and CPAP-2). Data are mean values from 12 male OSA patients.....106

Figure 4-10: Histogram showing the number of minutes (frequency) that 12 participants spent at different levels of AEE during the three 1 week study periods. AEE is depicted on the X axis in 0.1 MET increments ranging from 0.00 to 6.50 METs. Top panel depicts data collected during the Pre-CPAP period. Middle panel depicts data collected during the CPAP-1 period. Bottom panel depicts data collected during the CPAP-2 period.....108

List of Tables

Table 1-1: A comparison between the Pedometer and the Accelerometer.....	2
Table 1-2: Activity monitors use in clinical settings.....	21
Table 2-1: Participants' characteristics.	52
Table 2-2: Linear regression and correlation statistics showing relationship between Actiheart BEE estimates and BEE measurements made by indirect calorimetry during resting conditions and low to moderate treadmill walking in 6 healthy men.	54
Table 3-1: Exercise intensities for three modes of exercise used	65
Table 3-2: Anthropometric characteristics.	69
Table 3-3: VO_2 ($\text{ml}/\text{kg}/\text{min}^{-1}$) during three different exercises modes at four different levels of exercise intensity. Data are means \pm 1 SD for 10 healthy men.	70
Table 3-4: Oxycon mobile measurements of the BEE ($\text{kJ}/\text{min}^{-1}$) during three difference exercise modes at four different level of exercise intensity. Data are means \pm 1 SD for 10 healthy men.	70
Table 3-5: (RER) was measure via indirect calorimetry during three different exercises modes at four different levels of exercise intensity. Data are means \pm 1 SD for 10 healthy men.	70
Table 3-6: Actiheart based estimates of BEE ($\text{kJ}/\text{min}^{-1}$) during three different exercise modes at four different levels of exercise intensities. Data are means \pm 1 SD for 10 healthy men.	72
Table 3-7: Heart rate (bpm) during three different exercises modes at four different level of exercise intensity. Data are means \pm 1 SD for 10 healthy men.	74
Table 3-8: BEE ($\text{kJ}/\text{min}^{-1}$) estimated by the Actiheart system and measured by indirect calorimetry by the Oxycon mobile system in 10 healthy men during resting conditions and treadmill walking with zero incline at 3 , 5 , 7 km/hr.	79

Table 3-9: BEE ($\text{kJ}/\text{min}^{-1}$) estimated by the Actiheart system and measured by indirect calorimetry by the Oxycon mobile system in 10 healthy men during resting conditions and arm ergometry exercise at 150, 300 and 600 $\text{kpm}/\text{min}^{-1}$	79
Table 3-10: BEE ($\text{kJ}/\text{min}^{-1}$) estimated by the Actiheart system and measured by indirect calorimetry by the Oxycon mobile system in 10 healthy men during resting conditions and bicycle ergometry exercise at 150, 300 and 600 $\text{kpm}/\text{min}^{-1}$	79
Table 4-1: Anthropometric characteristics of 12 men recently diagnosed with OSA.....	99
Table 4-2: Daily AEE ($\text{kJ}\cdot\text{day}^{-1}$), ESS, FOSQ-30, and FOSQ domains at Pre-CPAP, CPAP-1 and CPAP-2. for 12 OSA participants.....	100
Table 4-3: Percentage of total time spent at different levels of AEE over the three 1 week actigraphic recording periods (Pre-CPAP, CPAP-1 and CPAP-2). Data are means \pm SD from 12 OSA patients. * $p < 0.05$ relative to Pre-CPAP, § $p < 0.05$ relative to Pre-CPAP. There were no significant differences.....	107

Contents

Dedication	ii
Acknowledgements.....	iii
Abstract	v
Declaration	vii
Conference Presentations and Abstracts	viii
Abbreviations	ix
List of Figures	xi
List of Tables.....	xv
Chapter 1 Literature review	1
1.1 Actigraphic Monitoring of Physical Activity	1
1.1.1 Introduction.....	1
1.1.2 Historical Development of Activity Monitors.....	2
1.1.3 Pedometers	3
1.1.4 Accelerometers	4
1.1.5 Estimation of Body Energy Expenditure from Accelerometers	8
1.1.6 Estimation of Body Energy Expenditure from Heart Rate.....	10
1.1.7 Estimation of body Energy Expenditure from Combined Heart Rate and Accelerometer monitoring.....	13
1.2 Clinical Application of Activity Monitoring	19
1.2.1 Adverse Health Outcomes Resulting From Sedentary Lifestyle	22
1.2.1.1 Factors Impacting on Levels of Regular Physical Activity.....	26
1.2.2 Clinical Conditions with Impaired Mobility	27
1.2.3 Clinical Conditions with Disturbed Sleep and Abnormal Circadian Rhythms	29
1.2.3.1 Cancer	31
1.2.3.2 Psychiatric Conditions	32
1.2.3.3 Sleep Disordered Breathing	33
1.3 Obstructive Sleep Apnoea	34
1.3.1 Pathophysiology of OSA	35
1.3.2 Comorbidities Associated with OSA	36
1.3.3 Treatment Options for OSA	37
1.3.4 CPAP Therapy.....	38
1.4 Actigraphic Evaluation of Daily Activities and Body Energy Expenditure in OSA	39
Chapter 2 Evaluating the Accuracy of Actiheart Derived Estimates of Body Energy Expenditure ...	42
2.1 Introduction.....	42

2.1.1	Aim of the study	43
2.2	Materials and Methods.....	43
2.2.1	Participants.....	43
2.2.2	Equipment	44
2.2.2.1	Actiheart.....	44
2.2.2.2	Oxycon mobile	44
2.2.3	Experimental Protocol	46
2.2.3.1	Equipment calibration and participant instrumentation	46
2.2.3.2	Rest and exercise protocol	47
2.2.4	Data Analysis	48
2.3	Results.....	52
2.4	Discussion	57
Chapter 3	Effects of Different Types of Exercise on the Accuracy of Actiheart Estimates of BEE in Healthy Participants	60
3.1	Introduction.....	60
3.1.1	Aim of the study	61
3.2	Materials and methods	62
3.2.1	Participants.....	62
3.2.2	Equipment	62
3.2.2.1	Exercise equipment.....	63
3.2.2.2	Body energy expenditure calibrations and participant instrumentation.....	63
3.2.2.3	Exercise equipment tests prior to the study.....	64
3.2.2.4	Exercise equipment tests during the study	64
3.2.3	Experimental Protocol	64
3.2.3.1	Rest and exercise protocol	66
3.2.4	Measurements.....	67
3.2.5	Data Analysis	67
3.2.6	Statistical Analysis	68
3.3	Results.....	69
3.4	Discussion	80
3.4.1	Introductory comments	80
3.4.2	Accuracy	80
3.4.2.1	Arm exercise	82
3.4.2.2	Treadmill and bicycle ergometry exercise	84
3.4.3	Critique of Methodology.....	84
3.4.3.1	Accuracy of Oxycon mobile, treadmill and ergometer equipment	84

3.4.3.2	Matching of exercise intensities for different exercise modes	86
3.4.3.3	Influence of RER on BEE	87
3.4.4	Clinical applications	87
3.4.5	Conclusion	88
Chapter 4	Actigraphic examination of OSA patients before and after commencement of CPAP.....	90
4.1	Introduction	90
4.1.1	Aim of the study	92
4.2	Materials and methods	93
4.2.1	Participants	93
4.2.2	Measurements	94
4.2.2.1	Anthropometric characteristics	94
4.2.2.2	Psychometric scoring of subjective measurements.....	94
4.2.2.2.1	Daytime sleepiness	94
4.2.2.2.2	Functional activity	95
4.2.2.3	Actigraphic measurements of daily activity	95
4.2.2.4	Experimental protocol.....	96
4.2.2.5	Data analysis	97
4.2.2.5.1	Analysis of Actiheart data.....	97
4.2.2.5.2	Statistical analysis.....	98
4.3	Results.....	99
4.4	Discussion	109
4.4.1	Relationship between daytime sleepiness and functional outcomes	110
4.4.2	Critique of Methodology.....	112
4.4.2.1	Protocol considerations	112
4.4.2.2	Validity of data from self-reporting questionnaires	113
4.4.2.3	Validity of Actiheart AEE estimates.....	113
4.4.2.4	Daily AEE profiles	114
4.4.3	CPAP Related Changes in the Daily AEE Profile	117
4.4.4	Clinical implications for OSA.....	119
4.4.5	Conclusion	123
Chapter 5	General discussion	126
5.1	Accuracy of Actiheart derived estimates of body energy expenditure during rest and treadmill exercise	127
5.2	Accuracy of Actiheart derived estimates of body energy expenditure during different types of exercise.....	128
5.3	The effects of CPAP on sleepiness and daily activity in OSA.....	129

5.4	Concluding remarks	132
	References	134
	Appendices.....	160