NATIONAL INSTITUTE OF PUBLIC HEALTH
UNIVERSITY OF SOUTHERN DENMARK

Physical activity pattern and its relation to glucose metabolism in Greenland

- a country in transition

PhD thesis

Inger Katrine Dahl-Petersen
Centre for Health Research in Greenland
December 2013

PhD thesis
National Institute of Public health, Faculty of Health Science
University of Southern Denmark

Physical activity pattern and its relation to glucose metabolism in Greenland

- a country in transition

Inger Katrine Dahl-Petersen
Centre for Health Research in Greenland
December, 2013

NATIONAL INSTITUTE OF PUBLIC HEALTH
UNIVERSITY OF SOUTHERN DENMARK

Preface

This thesis is based on data from the Inuit Health in Transition study in Greenland, which aimed to contribute to a better understanding of the health effects of the transition from a traditional lifestyle to a modern, industrialized life. The study was conducted as a collaboration between the Centre for Health Research in Greenland at the National Institute of Public Health, University of Southern Denmark, Steno Diabetes Center and the Department of Health in Greenland. Karen Elise Jensen's Foundation was the main source of funding for the study. The PhD was funded by Karen Elise Jensen's Foundation and the University of Southern Denmark. The data collection was carried out between 2005 and 2010. Both as a research assistant and during the PhD study at the Centre of Health Research in Greenland, I was lucky to be a part of the data collection team. Participation in the data collection allowed me to travel all over Greenland and gave me valuable insights in the study methods and procedures. It also left me with many fond and valuable memories and stories from the participants and of the peaceful, but at times challenging, nature. I wish to thank my supervisors Peter Bjerregaard, Marit Eika Jørgensen and Søren Brage for sharing their great insight and experience in the world of epidemiology and population health, and for the inspiring and stimulating discussions and talks about health among the population in Greenland, which have kept me motivated since my first stay in Greenland in 2004 and throughout the progress of my PhD. Thanks should also be given to the employees at Steno Diabetes Center, especially Anne-Louise Schmidt Hansen for providing me many Thursdays in a friendly and academically inspiring atmosphere, to Stefanie Mayle and Kate Westgate from the PA Tech team at the MRC Epidemiology Unit in Cambridge for expert assistance in processing combined sensor data, and Andreas W. Hansen for his valuable contribution as a co-author of one of the papers in this thesis. I have had the privilege of working with great colleagues and friends at the National Institute of Public Health, and I am grateful for the support they have given me. Especially, I want to thank my colleagues and friends at the Centre for Health Research in Greenland: Cecilia, Christina, Susanne, Ingelise, Charlotte, Anni and Nina for creating a supportive atmosphere with room for inspiring discussions and fun times also when things were busy, and especially to Susanne and Cecilia for help with the graphical layout and Vibeke and Majken for help with the English grammar. Above all, I owe my thanks to every single man and woman who participated in the Inuit Health Transition study in Greenland. Finally, I wish to thank my good friends and family for their patience and encouragement and especially Peter and Frida for dragging me out into the (wild) nature.

Inger Katrine Dahl-Petersen, December 2012.

"Tab for alt ikke lysten til at gå.
Jeg går mig hver dag det daglige velbefindende til og går fra enhver sygdom;
Jeg har gået mig mine bedste tanker til
og jeg kender ingen tanke så tung, at man jo ikke kan gå fra den."

Søren Kierkegaard

This thesis is based on the following papers:

Paper I: Dahl-Petersen IK, Hansen AW, Bjerregaard P, Jørgensen ME, Brage S.
Validation of the long International Physical Activity Questionnaire in the Arctic - measures of physical activity in Greenland; Medicine and Science in Sports and Exercise, 2013: 45(4): 728-736A.

Paper II: Dahl-Petersen IK, Jørgensen ME, Bjerregaard P.
Physical activity patterns in Greenland: A country in transition; Scandinavian Journal of Public Health, 2011; 39: 678–686.

Paper III: Dahl-Petersen IK, Bjerregaard P, Brage S, Jørgensen ME.
Physical activity energy expenditure is associated with 2-h insulin independently of obesity among Inuit in Greenland; Diabetes Research and Clinical Practice, 2013; article in press.
Included in this thesis in submitted form.

Academic supervisors:

Professor Peter Bjerregaard MD. National Institute of Public Health, Centre for Health Research in Greenland, University of Southern Denmark.

Marit Eika Jørgensen, PhD, MD. Steno Diabetes Centre, Gentofte Denmark.

Søren Brage, PhD. MRC Epidemiology Unit, Institute of Metabolic Science, Cambridge, United Kingdom.

Abbreviations

IHT 2005–2010	The Inuit Health in Transition study 2005–2010
PA	Physical Activity
PAEE	Physical Activity Energy Expenditure
MET	Metabolic Equivalence
HR	Heart Rate
Acc	Accelerometer
Acc and HR	Combined Accelerometry and Heart Rate monitoring
IPAQ-L	International Physical Activity Questionnaire, long version
BMI	Body Mass Index
WC	Waist Circumference
MVPA	Moderate and Vigorous intensity Physical Activity
LPA	Light intensity Physical Activity
OGTT	Oral Glucose Tolerance Test
IGT	Impaired Glucose Tolerance
IFG	Impaired Fasting Glucose
CI	Confidence Interval
OR	Odds Ratio
SE	Standard Error
SD	Standard Deviation

Table of contents

Introduction

Since the 1940s, indigenous populations in the Arctic, including Inuit in Greenland have undergone rapid cultural, economic and social changes accompanied by a modernization of lifestyle. Parallel to these changes, Greenland has experienced a major health transition with substantial increases in chronic diseases, such as type 2 diabetes (1;2). Recent studies in Greenland have shown a prevalence of type 2 diabetes at 7-10% among adult Inuit (2). Among the main causes, changes in habitual physical activity (PA) have been suggested (2). This PhD thesis focuses on PA in relation to the social transition within the country of Greenland and the impact on glucose metabolism. The traditional lifestyle in Greenland was characterized by physically demanding activities, such as subsistence hunting and fishing, berry picking, kayaking, dog sledging and transportation of water to the household. Today, these activities are still widespread all over Greenland, but more often as a leisure activity in the larger towns. Sedentary occupations have become more prevalent and mechanization of equipment, such as motorized boats, cars, snow mobiles, washing machines and computers, has resulted in a less physically challenging daily life. Sedentary leisure pursuits (e.g. TV and computer use) have become increasingly available, but also common modern leisure-time activities, such as football, skiing, biking and fitness training, have become popular all over Greenland, although there are large regional differences in the availability of such facilities. A population-based survey among adult Inuit in Greenland in 1993-1994 showed that a high level of PA during leisure time was more common in villages than in towns. The proportion of physically inactive individuals increased by age, and men were more physically active compared with women. In total, 22% of the population was physically inactive in leisure time during summer and winter (3). Information on PA across the Arctic is limited, and the use of different measures and measurement tools for PA complicates comparisons of PA patterns. Overall, the PA level is found to be lower among women than men, and to decrease by age, but the knowledge of how living conditions, income and educational level affect PA patterns is lacking (4-9). Only one prospective study has investigated how rapid cultural, economic and social changes have influenced PA patterns among indigenous populations in the Arctic (10). Since the level of adaptation to a westernized lifestyle still varies markedly within the population of Greenland, the opportunity to study the PA transition in relation to the social transition is obvious. Such studies can provide information to public health interventions with the aim of improving health in populations going through a similar process of social transition. This thesis is based on investigations carried out to contribute with novel information on PA patterns in an arctic population, and the central research question was: What characterizes the PA transition within the adult Inuit population in Greenland and how is PA associated with glucose metabolism.

Aims of the thesis

The overall aim of this PhD thesis was to evaluate PA patterns in an arctic population undergoing rapid social transition and to add to the epidemiological evidence of how PA relates to glucose metabolism in an

Inuit population in Greenland. Moreover, the thesis aimed to study the feasibility of a questionnaire-based measure of PA at a population-based level in Greenland by comparing questionnaire-based information with objectively measured PA. Three investigations formed the basis of the thesis. The aim of paper I was to validate the long International Physical Activity Questionnaire (IPAQ-L) against accelerometry and heart rate monitoring (Acc and HR) in the Inuit population of Greenland. The aim of paper II was to study the PA transition among Inuit in Greenland by examining differences in PA patterns in relation to the social transition. The aim of paper III was to analyze the association between objectively measured PA and glucose metabolism in Inuit in Greenland.

Background

The concept of physical activity and key definitions

Physical activity (PA) may be defined as*: "any bodily movement produced by skeletal muscles that result in energy expenditure"* (11). As an interpretational framework it is important to distinguish between exercise and PA. Exercise is a subcategory of PA and includes sports activities that are planned, structured and repetitive in order to maintain or improve physical fitness, overall health and well-being, and often these activities are performed at vigorous intensity. Besides exercise, PA comprises activities of daily life involving any bodily movement as well as activities such as active transportation (walking and biking), household activities, and occupational PA. These activities are normally unstructured activities, performed at varying levels of intensity. The focus of this PhD thesis is on the habitual PA during daily life. PA can be categorized into domains of daily life: leisure time, household and gardening, occupation and transportation, and comprises four different subdimensions: frequency, duration, intensity and type (12). The thesis will focus on all four dimensions and domains of PA. Frequency relates to how often or how many bouts of PA are performed e.g. daily, weekly or monthly. Duration refers to time spent on PA, most often described in minutes or hours of PA. Intensity refers to how much effort is required to perform the specific activity, e.g. rate of energy expenditure per unit of time. The intensity can be expressed relatively in percent of maximal oxygen uptake (VO2max), as resting metabolic rate (RMR) or as absolute intensity, most often expressed in MET (Metabolic Equivalent Task), with 1 MET corresponding to a standard value for the resting metabolic rate; 3.5 mL $O_2 \cdot kg^{-1} \cdot min^{-1}$ (13;14). PA can be divided into light, moderate and vigorous intensity according to the rate of energy expenditure. Moreover, energy expenditure of specific types of PA can be quantified. Widely accepted is the use of the Compendium of physical activities now presenting 821 MET values for specific activities of daily life (13-15). Figure 1 illustrates the continuum of PA and the corresponding rate of energy expenditure in MET. The type of PA refers to the specific PA behaviour, such as running or walking, or the classification of an activity into aerobic or anaerobic. Duration and frequency can be multiplied providing total amount of time spent on PA. These durations can be multiplied with the intensity of each activity type or category ($activity_i$) and added up across activities ($\sum Duration_i \times frequency_i \times intensity_i$); this sum is referred to as the total PA energy expenditure, expressed for example in MET-hrs per week, kcal per week, or kJ/kg/day (16).

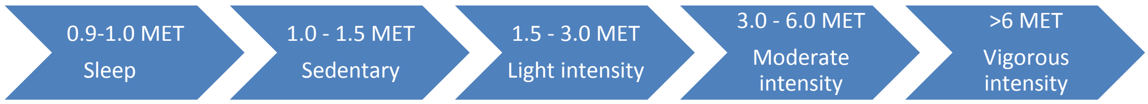


Figure 1. Overview of the continuum of PA and the energy expenditure corresponding to the specific activities (14).

The impact of physical activity on public health

Worldwide, it has been estimated that physical inactivity causes 6-7% of the burden of disease from major non-communicable diseases like coronary heart disease and type 2 diabetes, and 9% of premature mortality (17). Inactivity is concluded to be a risk factor similar to that of smoking or obesity (17). Since the study of London transport workers in 1953 showed that the physically active conductors on double-deckers were at lower risk of coronary heart disease compared with the sedentary drivers (18), the number of studies on PA and health has substantially increased, and the evidence has been summarised in several consensus documents (19-21). Evidence from a recently published prospective cohort study showed that individuals who performed as little as 15 minutes a day or 90 minutes a week of moderate-intensity exercise had a 14% reduced risk of all-cause mortality and a 3-year longer life expectancy compared with inactive individuals in all age groups, for both men and women and for those with cardiovascular disease risks (22). A positive dose response effect of total PA on health has also been documented (23;24). A meta-analysis concluded that some PA is better than none, and that additional health benefits occur with more PA (25). Studies have identified a great potential in increasing the level of PA, particularly among the most inactive individuals (22); however, whether there is a specific threshold for the effect of PA energy expenditure (PAEE) on health and how specific intensities influence health still need further clarification. This information can be used in recommendations for PA. In Greenland, the current National recommendation is one hour of daily PA for both adults and children, however, without specifying the recommended level of intensity (26).

The physical activity transition in populations undergoing rapid transition – what is the problem?

In Greenland, social changes started to evolve rapidly at the beginning of the 20th century when cod fishing was replacing the traditional hunting of sea mammals as the main livelihood of the Inuit, and cod were sold for cash (27). After World War 2, Greenland went through rapid cultural, economic and social changes characterized by population movement from small villages to larger towns, changes in living conditions and increased availability of formal education (1;27;28). These changes were accompanied by a more modernized lifestyle, especially in the larger towns. Parallel to these changes, Greenland experienced a major health transition with a gradual reduction in the prevalence of tuberculosis and acute infectious diseases, paralleled by a substantial increase in chronic lifestyle diseases, such as type 2 diabetes and obesity, and increasing prevalence of mental health problems, such as youth suicides, and alcohol problems (1;2;29). In this regard, the history of Greenland shares similar traits with the epidemiological transition among populations undergoing rapid social, cultural and economic changes in other parts of the world (30-32). In the framework of the epidemiological transition, the physical transition explains how rapid changes in PA have occurred in parallel with the increasing prevalence of obesity and other chronic diseases (33). According to Katzmarzyk and colleagues "the physical activity transition seeks to explain the potential effects of changes in PA on health and life expectancy in countries experiencing rapid economic development" (33). The consequences of the PA transition are relevant for all populations, but may be more marked in populations experiencing rapid social change, such as Inuit in Greenland. Little is known about how PA has changed in relation to the agrarian, industrial and technological breakthrough. Among indigenous populations in the Arctic, a cross-sectional comparison among the Yakut of Siberia found that total energy expenditure (TEE) adjusted for body mass was correlated with participation in subsistence activities, such as hunting and fishing. Individuals with a traditional lifestyle reflecting participation in subsistence tasks had higher energy expenditure than individuals with a more modern lifestyle, indicating a decrease in PA with modernization (34). Contrary, a study among Hadza hunter-gathers in Tanzania presented similar daily energy expenditure as their Western counterparts and suggested the energy expenditure to be independent of cultural differences (35). The impact of the transition from a traditional hunter-gatherer lifestyle to a more Western lifestyle on physical fitness levels has only been exemplified in one prospective study a 20-year study in an Inuit community in the Northwest Territories, which showed a temporally decreasing level of fitness along with rapid acculturation and an increasing sedentary lifestyle (10;36).

Physical activity and glucose metabolism among indigenous populations in the Arctic

Worldwide, the prevalence of diabetes is expected to increase from 4.0 to 5.4% (35% increase) between 1995 and 2025, with a proportionally greater increase in developing countries and a considerable excess of diabetes in urban areas by 2025 (37). Physical inactivity is a strong and well-known risk factor for type 2 diabetes (38-43). The potential of PA in the treatment of type 2 diabetes is also well established in several larger intervention studies (44-47). Most of the evidence on PA and metabolic risk is based on studies in Western populations, and only a few studies have investigated the association among indigenous populations in the Arctic. One study showed a positive effect of PA on fasting insulin concentrations in a subarctic native Canadian population (48). Another study demonstrated an association of PA with the prevalence of Impaired Glucose Tolerance (IGT) and diabetes in Greenland (2), and a study among Yup'ik Eskimos and Athabaskan Indians in Alaska showed that a moderate and high level of PA were associated with a lower prevalence of glucose intolerance compared to a reference group with a low level of PA (49). In Greenland, physical inactivity due to a decrease in subsistence hunting and fishing activities was suggested to explain, that Westernization was found to increase the metabolic risk for men only (50). Contrary, another study in Greenland found a higher prevalence of type 2 diabetes and glucose intolerance in rural areas compared with towns despite a higher level of PA in rural areas (66). These studies are all based on self-reported PA, and only a few studies (51-56), all conducted in non-Arctic populations, have reported on objectively measured free-living PA and its association with glucose metabolism. Information from such studies is important as a part of the prevention of further increases in type 2 diabetes in this population.

Differences in living conditions as a marker of the PA transition and type 2 diabetes

To examine differences in PA patterns in relation to epidemiological transition changes or modernization, most research has used an urban-rural dichotomy as a model, mainly since longitudinal PA data are almost non-existent. A review of studies in developing countries summarized that both men and women living in urban areas were more likely to be inactive compared with those living in rural areas (57). Studies in populations undergoing transition have found that urban living is associated with lower PA and higher prevalence of pre-stages of- and type 2 diabetes (52;58-63) and research in developing countries and countries undergoing rapid transition has shown that the risk of impaired glucose metabolism increases with urbanization (64;65). This is contrary to Greenland, where a population-based study showed higher prevalence of type 2 diabetes and glucose intolerance in rural areas compared with towns (66). In addition to current residence, a study found that both lifetime exposure to an urban environment and recent migration history influenced the association between obesity and diabetes (67). Overall, there are considerable differences in the definition and measurements of urbanity, modernization and social change, and in a review investigating how urbanization has been measured, it was emphasized that measures of urbanization as a process are needed to obtain more detailed information on changes in urbanicity and impact on health (68).

Detailed information about the disease patterns of indigenous peoples in the North has only during the last generation become available, and, therefore, the health impact of social change can only be studied at the ecological level. In a recent study among Inuit in Greenland, we examined the secular differences in the health outcomes between two population-based surveys among adult Inuit in Greenland in 1993-1994 (N =1,580) and 2005-2009 (N=2,834). Furthermore, we defined and ranked six subgroups; from participants at a presumed early stage of social transition (more traditional) to those at a later stage (more modern), defined from current and childhood residence in a village or town, family job type, and education. We compared the distribution of socioeconomic, behavioral, and clinical/biochemical risk factors for cardiovascular disease among these groups, using data from the Inuit Health in Transition Greenland Survey 2005-2009, with the secular trends found from the two surveys. We found that in the absence of longitudinal data, cross-sectional data could be used, although with caution, to mirror social change for selected analyses of cardiovascular risk (69). This grouping was used in paper II as a proxy for changes in PA patterns along with the social transition.

Measurements of population-based physical activity in a non-Western context

Using adequate measures of PA is fundamental in the assessment of PA, whether the purpose is to measure time trends, associations with health outcomes or to evaluate interventions to promote PA. When interpreting the results on PA one must take the quality of the measurement tools into consideration (70). Properties, such as validity, reliability and responsiveness, are not always assessed or they have been studied differently, which makes it difficult to rate one questionnaire better than the other (70;71). Further, the diversity of questionnaires available are substantial due to the fact that different questionnaires have been developed for different purposes (e.g. surveillance, activity group categorization, etiology). The population-based studies of PA worldwide are still mainly based on self-reported information obtained through interviews or self-administered questionnaires. However, most questionnaires have been developed for use in non-indigenous populations, and the reliability and validity are far from always examined in the specific cultural setting where the questionnaire is used. The International PA Questionnaire was developed to measure PA in different cultural settings and has been widely used worldwide (72). The questionnaire exists in a short (IPAQ-S) and a long (IPAQ-L) form and as interviewer- or self-administered. The short form is recommended for national monitoring (7 items), whereas the long version is more comprehensive (27 items) and assesses time spent at different intensities of PA within four domains of daily life: transportation, work, leisure time, and domestic activities (73). The IPAQ has been translated, adapted, used and validated in several populations, including populations undergoing transition (74-77). Craig and colleagues found in a 12-country evaluation that the IPAQ was as reliable and valid as other questionnaires. However, the questionnaire showed different validity used in different populations (78), which underlines the need to assess the measurement properties in the specific target population.

The gold standard for measuring PA energy expenditure (PAEE) is a combination of doubly labelled water (DLW) and measurement of resting metabolic rate; however, this method is not feasible to use in population-based surveys and does not provide information on duration, domains and intensity (79).The advancing technological possibilities have resulted in increasing possibilities to use device-based measures on a large study population (80). Most common is the use of different kinds of accelerometers, pedometers and heart rate monitors. Accelerometers (uni- or tri-axial) provide measures of biomechanical intensity, duration and frequency, and has been shown to provide greater precision when compared to self-reporting of the total amount of PA and energy expenditure spent on specific activities (81) but also present limitations regarding information on certain activities, such as upper-arm activities, kayaking, weightlifting and cycling as well as high-intensity PA, and provide no information about the domain in which the activity is performed (82;83). Heart rate monitoring can be used as an objective measure of energy expenditure based on the premise that heart rate and oxygen consumption are linearly related (84;85). However, heart rate is easily influenced by factors such as medicine, temperature and fitness, and is most suitable for measuring activities at high intensity(84). The combination of accelerometry and heart rate monitoring has been shown, in most cases, to provide a more precise and accurate estimation of the energy expenditure for PA among both adults and children, compared with each of the methods used alone, and this method has been validated in a non-Western context (86-88). However, the method also presents methodological challenges, such as wear-time issues and cost. Figure 2 presents an overview of different methods and the inverse relationship between validity and feasibility (Søren Brage, personal communication).

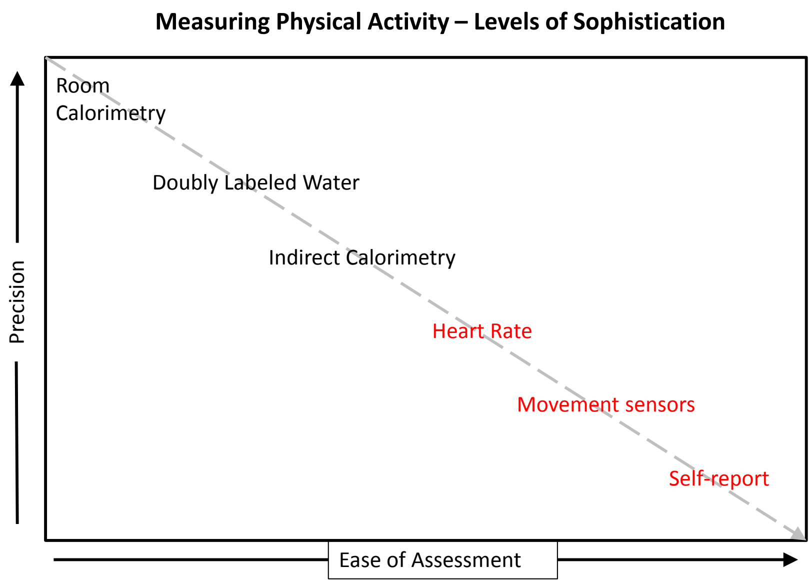


Figure 2. Overview of different methods and the inverse relationship between validity and feasibility. Søren Brage, personal communication.

Material and methods

The Inuit Health in Transition Study

The present PhD thesis is based on data from the Inuit Health in Transition Greenland Survey 2005-2010, which is a part of an international collaboration across the Arctic including Inuit in Greenland, Canada (Nunavik and Nunavut) and Alaska. The Inuit Health in Transition Study (IHIT) was designed as a longitudinal cohort study with the purpose of studying the interaction between the environment and genetic factors on the health and disease pattern of the Inuit in the regions of Greenland, Canada and Alaska. Thus, the project in Greenland is part of an international study with data collection in several villages and towns in all three countries. The project aimed to contribute to a better understanding of the health effects of the transition from a traditional lifestyle to a modern, industrialized life, which takes place in most present-day developing countries. One of the specific aims of the study was to assess risk factors for cardiovascular disease and diabetes. This PhD thesis is based on the initial cross-sectional data. A follow-up has been scheduled in 2014 for both Nunavik and Greenland.

Places of data collection and procedures

Figure 3. Map of Greenland with study communities, names of the towns included. Inuit Health in Transition Greenland Survey 2005-2010.

Greenland – or Kalaallit Nunaat in Greenlandic - is the world's largest island and a country in the Arctic with a population of about 57,000, of whom 90% are ethnic Greenlanders (Inuit). Genetically, Greenlanders are

Inuit (Eskimos) with a mixture of mainly Danish genes, and are genetically and culturally closely related to the Inuit/Iñupiat in Canada and Alaska and, somewhat more distantly, to the Yupiit of Alaska and Siberia. Only 18% of the total area of the island is free of ice. Greenland's 80 communities are all located on the coast and are divided into towns (with population ranging between 469 and 15,469) and villages (with population ranging from less than 10 to about 550) with no connecting roads.

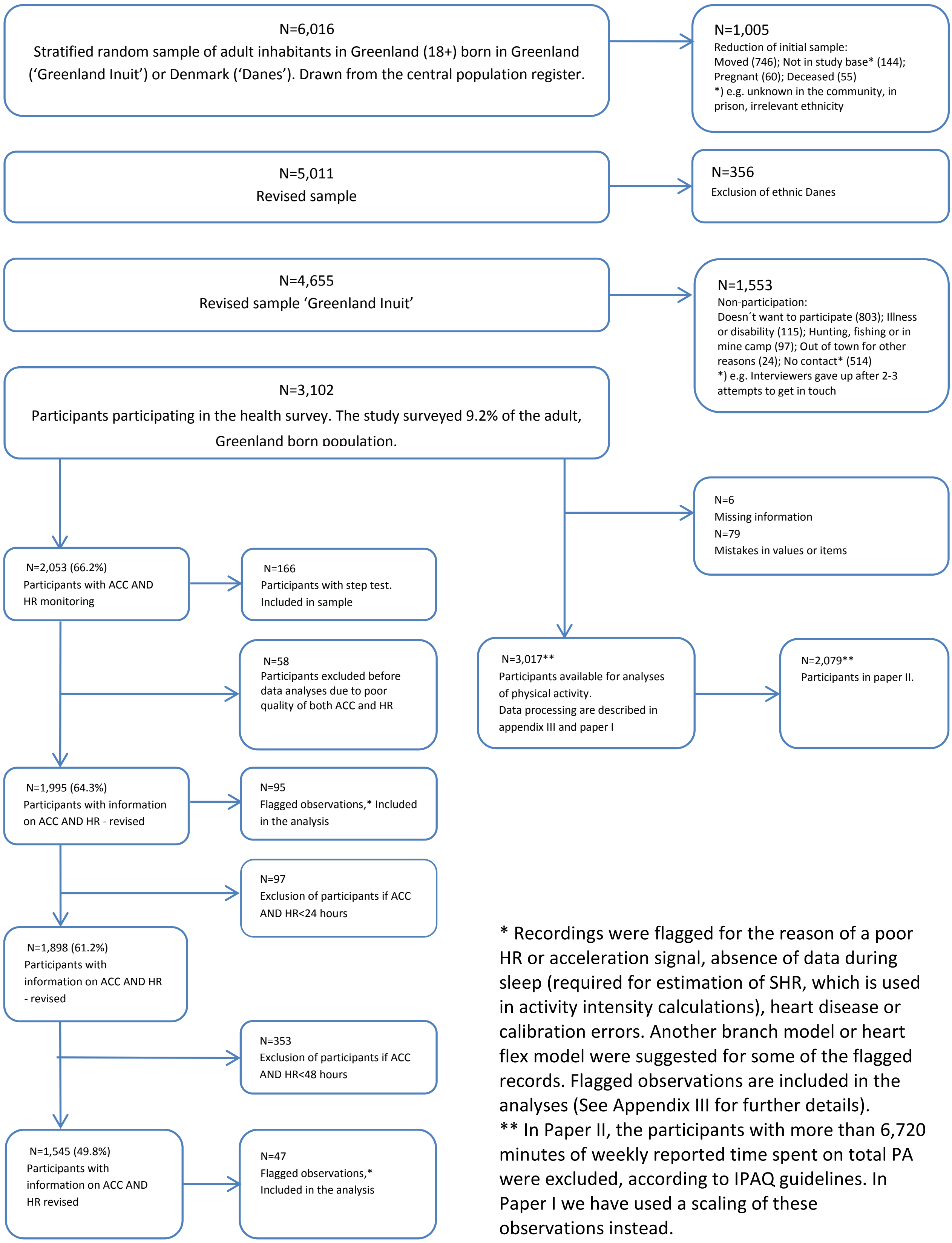
The data collection took place from 2005 to 2010, both during summer and winter time. For logistical reasons it was not possible to distribute the data collection in the specific communities throughout the year. With the exception of Upernavik, Tasiilaq and Qaanaaq, the towns were visited by public transport (flight) and the villages were visited on three expeditions by a chartered boat (m/s Kisaq) (figure 3). Data was collected by a team of local persons responsible for the recruitment of participants, a supervisor, one or two laboratory technicians, 2-4 interviewers, and two clinical assistants. The participants were informed about the investigation by a personal letter, and after the arrival of the team they were contacted by the person responsible for recruitment. The participants were asked to show up fasting (i.e. at least 8 hours without eating or drinking), they were informed about the investigation and signed an informed consent. The participants went through a 2-hour oral glucose tolerance test, interview, filled in a questionnaire, went through various clinical tests and were provided with the Actiheart device (combined accelerometer and heart rate monitor). The interviews were conducted in both Greenlandic and Danish according to the choice of the participant. After 2 hours, another blood sample was drawn. At the end of the session, participants were informed about the results of the investigation. When the Actiheart device was returned, a compensation of DKK 200 was paid to each participant.

Population sample

Participants for the Inuit Health in Transition Greenland Survey were selected as a stratified random sample of adults aged 18 years and older and born in Greenland or Denmark. Greenland was divided into strata based on geography (Southwest coast; Central West coast; Northwest coast; East Greenland; North Greenland) and community size (towns with ≥ 2000 inhabitants; towns with < 2000 inhabitants; and villages). From each of these strata one or more towns and 2-3 villages were selected for the study as being representative of the stratum with regard to living conditions. A random sample was drawn from the central population register to obtain around 300 participants from each town; this number represents the practical limit for a research team during a 4-6 week visit. Villages were chosen at random in the strata, and in the selected villages all adults were invited to participate. We collected data in 9 towns and 13 villages in Greenland. At the study location, the invited participants were contacted by telephone, person-to-person or contacted by asking their neighbor of their whereabouts. The final sample was revised to exclude participants no longer living in the community, pregnant women and deceased persons. Ethnicity as Greenlander or Dane was determined at enrolment, based on the primary language of the participant and self-identification. The current PhD thesis focuses on Greenlanders only. According to community size, the participation was 61.4% in Nuuk (the capital), 65.1% in other large towns, 69.9% in small towns and 68.5%

in the villages ($p<0.001$). Participation rates also varied by age and sex. Women were more likely than men to participate, and particularly young men were under-represented. The reasons for non-participation can be seen in the flow chart (figure 4).

The Inuit Health in Transition – Greenland Survey 2005-2010



* Recordings were flagged for the reason of a poor HR or acceleration signal, absence of data during sleep (required for estimation of SHR, which is used in activity intensity calculations), heart disease or calibration errors. Another branch model or heart flex model were suggested for some of the flagged records. Flagged observations are included in the analyses (See Appendix III for further details).
** In Paper II, the participants with more than 6,720 minutes of weekly reported time spent on total PA were excluded, according to IPAQ guidelines. In Paper I we have used a scaling of these observations instead.

Figure 4. Overview of the study sample and drop-outs.

Ethical considerations

The study was approved by the Ethical Review Committee for Greenland. Participants were informed about the study objectives and the data collection procedures orally and in writing, and accordingly gave their written informed consent.

Outcome measures and exposures

Measures of physical activity

The International Physical activity Questionnaire – long version

In this PhD thesis information on PA was collected using a modified version of the interviewer-administrated seven-day International Physical Activity Questionnaire (IPAQ) (long version) (IPAQ-L). Participants were asked to report time spent on PA in the previous seven days: how often (number of days per week) and for how long (average duration per day). Questions were asked separately for vigorous intensity, moderate intensity and walking in the four domains: work, transportation, domestic and leisure time. Participants were also asked to report number of days and time spent sitting during the week and in the weekend. The original English version of the PA questionnaire was translated into Greenlandic and back-translated by two interpreters bilingual in Danish and Greenlandic and familiar with Greenlandic living conditions. The questions were adjusted to arctic living conditions by replacing some of the activity examples with culturally relevant examples based on a pilot study comparing IPAQ-L and a short questionnaire with combined Acc and HR in Greenland. In the domestic domain we combined the two questions concerning moderate intensity (outdoor and indoor activity) into one; gardening is non-existent in arctic living conditions, and common activities such as getting fishing equipment ready take place both inside and outside the house. Data were initially scored according to guidelines from the IPAQ group (89). Some exceptions were made, as described in detail in paper I. An overview is also provided in appendix IV. PA energy expenditure was calculated by multiplying time reported (minutes/week) by the net metabolic cost of each activity, which was expressed in metabolic equivalents *(METs).* The net metabolic cost of each activity was assigned according to the PA Compendium's gross MET values (13), subtracted by 1 MET to account for resting metabolic rate (RMR). An estimate of total daily sedentary time was calculated from time spent sitting, such as TV and computer use and reading. In paper I we added 8 hours as presumed time spent sleeping (sleep information not included in IPAQ-L) (Appendix 1, the Greenlandic version of IPAQ-L).

70.	**During the last 7 days, on how many days did you do vigorous physical activities in your home?** *(for instance heavy lifting, shovelling snow, digging, fetching water)* _____ days per week Did not do vigorous physical activity at home .... ☐ 2→ go to quest. 72
71.	**How much time did you usually spend on one of those days doing vigorous physical activities in your home?** _____ hours per day _____ minutes per day

Figure 5. Example of question in IPAQ-L. Vigorous PA in the domestic domain. PA examples adapted to Greenlandic living conditions.

Combined accelerometry and heart rate monitoring

As a part of the clinical health examination we issued a combined accelerometer and heart rate monitor (ACC and HR) (Actiheart®, CamNtech Ltd, Cambridge, UK) to a subgroup of the participants all over Greenland (n=2053). The monitor was set up to measure acceleration and heart rate at 30-second intervals and attached to the participant's chest by two standard ECG electrodes (MXC55 MediMax UK)(figure 6). The participants were told to leave the monitor on for 24 hours a day, also for sleep and showering. A subgroup of participants conducted an individual calibration test (8-minute step test). Step tests were used to define a population-specific calibration equation of the heart rate-activity energy expenditure relationship. Due to study logistics (travel distances, weather conditions and the data collection time schedule), only limited time was available at each study location, especially for data collection in villages. Together with a finite stock of monitors, this explains why not all participants were given a monitor, and why the length of recordings from some participants was of shorter duration. A detailed description of data processing and sample is available in paper I and appendix III. Caloric intensity of PA was estimated by combining the acceleration-based estimate of intensity (90) with the heart rate-based estimate from the population-specific equation in a branched equation modelling framework (91). Briefly, this method predominantly uses the accelerometer estimate during low levels of heart rate and movement, and the heart rate estimate when both heart rate and acceleration levels are high, with equal weighting for other conditions (appendix III for details on branched equation). Resulting time series of activity intensity (in J/min/kg) were summarised into total PAEE (in kJ/kg/day) and time spent at different intensity levels (sedentary as <1.5MET, moderate as 3-6MET, and vigorous as >6MET). We included individuals with >48 hrs of monitor wear data.

Figure 6. The placement of a combined accelerometer and heart rate monitor.

We validated the interviewer-administered long form of the International Physical Activity Questionnaire (IPAQ-L) modified and adapted to arctic living conditions (paper l) and utilized it for analyses of patterns of PA in relation to social transition in paper II. The combined accelerometer and heart rate monitor was applied in a subsample of the participants. In paper I this method has been used as a criterion measure for validation, and in an addition to paper II as a descriptive outcome measure across transition categories, and in paper III as exposure in an etiological analysis of the association with precursors of type 2 diabetes.

Interview with main interviewers

We conducted individually based interviews with the main interviewers about their experiences of interviewing about PA and how the questions were interpreted by the participants. Moreover, preliminary results were presented and possible explanations were highlighted by the interviewers. The answers from the interviewers were used in paper I and as background knowledge on how the concept of PA, including intensities and domains, is being interpreted in Greenland.

Measures of glucose metabolism

After a minimum of 8 hours of fasting, participants underwent a standardized 2-hours oral glucose tolerance test (75 g), except for those with known type 2 diabetes at the time of health examination. Fasting and 2hr blood samples were taken. Plasma glucose was measured fasting, plasma was separated and frozen at –20°C and transported to one central laboratory for measurement of plasma glucose. Serum insulin was analyzed with a flouroimmunoassay technique. The inter assay precision CV was 6%. Non fasting participants (self-reported) or participants with known type 2 diabetes were not included in the further analysis involving glucose and insulin parameters. Glucose tolerance; impaired fating glucose (IFG), impaired glucose tolerance (IGT) and type 2 diabetes were classified according to WHO criteria (table 1).

Table 1. WHO diagnostic criteria for diagnosis of diabetes mellitus and intermediate hyperglycemia (World Health Organization 1999).

	WHO Diagnostic Criteria
IFG	Fasting plasma glucose from 6.1 to 6.9 mmol/l and 2h plasma glucose <7.8 mmol/l
IGT	Fasting plasma glucose <7.0 mmol/l and 2h plasma glucose ≥7.8 mmol/l and <11.1 mmol/l
Diabetes	Fasting plasma glucose ≥7.0 mmol/l or 2h plasma glucose ≥11.1 mmol/l

Anthropometric measures

Height (nearest 0.1 cm) and weight (nearest 0.1 kg) were measured with the participants wearing underwear. BMI was calculated as weight/height^2 (kg/m^2). Waist circumference was measured midway between the rib cage and the iliac crest, hip circumference at its maximum on the standing participant. Weight was measured on a standard electronic clinical scale. Bioimpedance and calculation of fat percentage were performed on a leg-to-leg Tanita TBF-300MA. Based on a single reading, fat percentage was calculated by the internal algoritm of the device, which is based on height, weight, sex, impedance and age; body type was set to "standard".

Sociodemographic variables

From the interviewer-administrated questionnaire, residence at age 10 was obtained and recoded into residence in village or town. Job type was determined from questions about job title of participant and spouse. Formal education was determined from questions about highest school education attained and further vocational or academic education and recoded as primary school/high school only, short vocational education (less than three years), and longer vocational/academic education. Place of residence was divided into the capital of Nuuk, villages and towns.

Social transition

Individuals were divided into six groups defined from occupation type, education, and place of residence (present and 10 years old). This variable is used in paper II as a proxy for secular changes:

A. hunters and fishermen in villages;
B. other inhabitants of villages;
C. blue-collar migrants (inhabitants of towns, with no vocational education, having lived in villages at age 10);
D. other blue-collar participants (inhabitants of towns, with no vocational education, having lived in towns at age 10);
E. intermediate (inhabitants of towns, with short vocational education);
F. professionals (inhabitants of towns, with longer vocational or academic education).

In order not to misclassify participants who had not yet finished their education and to minimize the proportion of participants outside the workforce, analyses only included those aged 25-64 years.

Confounders

In papers I and II, we stratified the analyses by sex, age group and place of residence. In analyses of the association between PAEE and glucose metabolism outcomes (paper III), information on smoking habits, family history of diabetes, sex, age, BMI, waist circumference (WC) and fat percentage was included in regression analyses to address the issue of confounding and mediating by these variables.

Data analysis

The analyses were performed in STATA 10-12 and SPSS 18.

Paper I

The association between questionnaire- and monitor-based PA estimates was examined by the non-parametric Spearman rank correlation coefficient (ρ). Level of agreement was examined by modified Bland-Altman plots (Bland and Altman) (92). Bland and Altman recommend graphical presentations (plots) for method comparison, so that the error structure can be explored throughout the range of the variable of interest. We used a modification of the classic Bland-Altman plot by plotting the difference between the measurements (IPAQ-L minus Acc and HR) against the objective estimate; with lines indicating the median difference (median bias) and 95% limits of agreement (2.5 and 97.5 centiles of the difference). Median instead of mean and centiles of the difference instead of 1.96SD of the difference were used due to the non-normal distribution of data (non-parametric). Moreover, we chose to plot the difference against the absolute measure of PA by accelerometry and heart rate monitoring, because we considered this monitor-based measurement as a more accurate and precise representation of the true underlying exposure, compared with the questionnaire data. The differences of the medians were analysed by a Wilcoxon signed-rank test. Sensitivity analyses were performed including only participants with ≥72 hours Acc and HR of valid monitoring data.

Paper II

Time spent on PA was presented in median hours per day with interquartile ranges for each domain of PA as well as for total PA. Differences in time spent on PA across social transition groups were tested using a multiple linear regression model with time spent on PA as dependent variable. A square root transformation of time spent on PA was applied in order to approximate a normal distribution of the variable. The analyses were stratified on sex and adjusted by age. A test for linear trend in PA across the six transition groups was applied adjusted for age (Likelihood-ratio; STATA version 10). Moreover the proportion of participants that did not report any time spent on PA in the specific domains of PA was presented. Time spent on moderate and vigorous intensity PA was analyzed. No transformation was applied for time spent on sedentary activity.

Paper III

Associations between PAEE and glucose outcomes were analyzed in multiple linear regression models. Potential confounders and mediators were chosen a priori: age, sex, WC, family history of diabetes and smoking were included stepwise. Three models were presented; model A: no adjustments; model B: age and sex adjustments and model C: further adjustments by WC. Interaction terms were included, and models with and without interaction were compared using a log likelihood ratio test. The variable $PAEE^2$ was included to test and adjust for nonlinearity. The distribution of outcome variables was graphically viewed before analysis (qqplot), and a model control was performed to test if the variance of the residuals was normally distributed. Accordingly, fasting and 2-hour insulin concentrations were logarithm transformed before analysis and back-transformed and reported as percentage decrease or increase. Impaired fasting glucose (IFG), impaired glucose tolerance (IGT) and type 2 diabetes were classified (dichotomized). Logistic regression models were utilized to compare individuals with diabetes versus individuals with Normal Glucose Tolerance (NGT), individuals with IGT versus NGT+IFG and individuals with IFG versus NGT.

Summary of main results

Is the International Physical Activity Questionnaire valid to use in an arctic population?

This validation study is based on PA data from IPAQ-L and Acc and HR monitoring (n=1508 adult Inuit). Questionnaire-based PAEE was moderately correlated with accelerometry and heart rate monitored PAEE (r=0.20–0.35, p<0.01). The agreement analysis showed that the median difference for the level of PAEE measured by the two methods was small and indicated a moderate agreement between the two methods; however, 95% limits of agreement were wide. This pattern was similar for subgroup analyses of sex, place of residence (Nuuk, town, village) and age groups. A weak correlation was found for questionnaire-based time spent at different intensities of PA (moderate and vigorous) and sedentary time versus Acc and HR monitoring (r=0.11–0.31). The agreement plots showed that time spent at moderate intensity PA was substantially over-reported by IPAQ-L when walking was included as a moderate intensity activity (>1.5hrs/day, p<0.001); however, the agreement was substantially better when excluding walking (figure 7).

Table 2. PA characteristics. Self-reported (IPAQ-L) and objectively measured PA (Acc and HR) presented as daily physical activity energy expenditure (PAEE). Inuit in Greenland, n=1508.

	Total PAEE (kJ/day/kg)		**P value**
Sex			
Men n=659			
Self-report	51.7	23.6-97.0	0.2
Objective measure	56.6	40.3-75.5	
Women n=849			
Self-report	47.3	24.9-76.9	**0.002**
Objective measure	45.7	34.2-60.1	
Place of residence			
Nuuk n=323			
Self-report	45.9	24.2-80.9	0.3
Objective measure	50.9	36.6-64.1	
Towns n=906			
Self-report	48.4	23.6-85.0	**0.06**
Objective measure	49.6	36.2-67.8	
Villages n=279			
Self-report	50.0	30.0-86.3	**0.02**
Objective measure	49.4	36.8-66.2	

Table 2 (continue)	Total PAEE (kJ/day/kg)		P value
Age groups			
18–44 years n=829			
Self-report	57.7	33.2-92.3	**0.04**
Objective measure	57.8	44.6-75.2	
45–54 years n=349			
Self-report	47.5	23.3-85.7	**0.02**
Objective measure	47.2	34.3-60.1	
55+ years n=330			
Self-report	31.6	15.3-57.7	0.6
Objective measure	34.3	22.5-47.5	

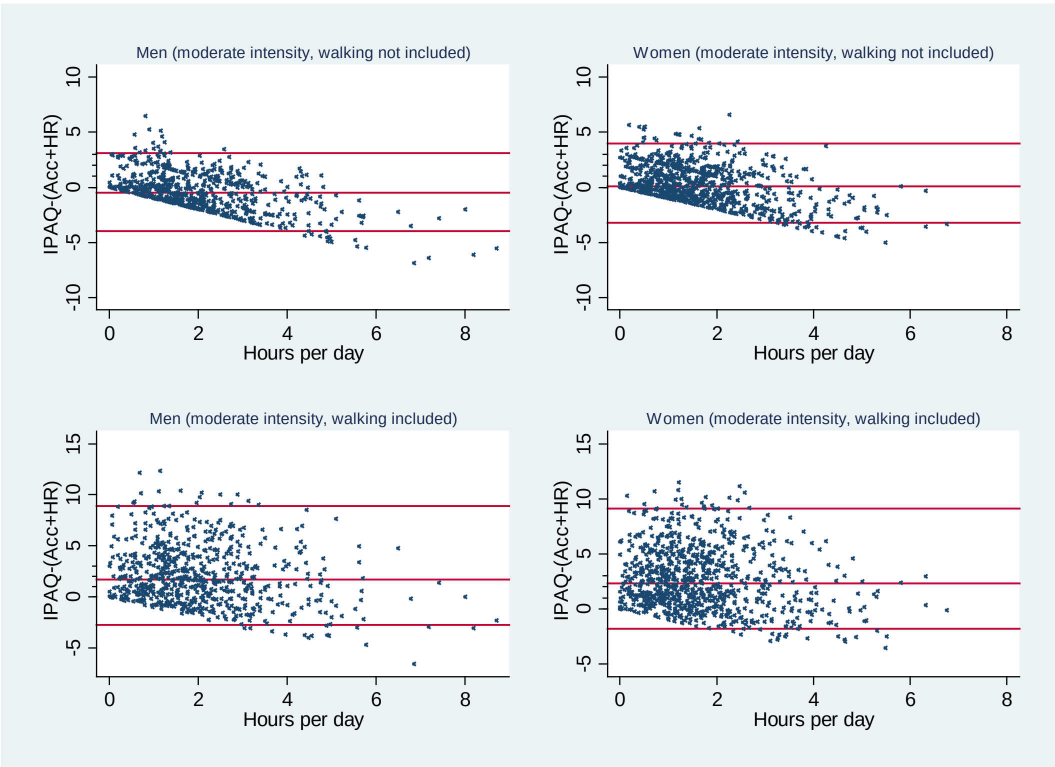


Figure 7. Median difference between self-reported and objectively measured time spent at moderate intensity PA (IPAQ-Acc and HR) plotted against (Acc and HR) stratified on sex (presented with and without walking included). The lines represent median and 2.5 and 97.5 centiles. Inuit in Greenland, n=1508.

Is there an association between physical activity patterns and social transition in Greenland?

Based on data from IPAQ-L (n=2079 adult Inuit), we found that total age-adjusted hours spent on PA were significantly higher among hunters and fishermen living in villages compared with wage earners with long vocational or academic education living in towns (men p<0.001; women p=0.002); however, no significant linear trend in relation to social transition was shown. For men and women in the latest stage of social transition, men spent significantly less time on occupational PA and women significantly less time on domestic PA compared with men and women with the most traditional lifestyle and a linear negative trend was found in the level of PA by stage of social transition for men (p=0.01) and for women (p=0.06). Significantly less time was spent on PA during transportation for men and women in the latest stage of social transition compared with the earliest stage (men p=0.02, women p=0.01). No significant differences were found for time spent on leisure time PA in relation to social transition. The average time used on sedentary behavior increased along the stages of social transition (p<0.001). In preliminary unpublished analyses, we examined the distribution of time spent at different intensities of PA and total PAEE in relation to the six transition groups based on data from Acc and HR monitoring. The results are presented in table 3 and table 4. Overall the results indicated a linear trend for decreasing PAEE with stages of social transition for men, but not for women. No significant linear trend was identified for time spent at different intensities of PA, although a borderline significant trend was found for decreasing time spent at vigorous intensity PA for men only (p=0.08).

Table 3. Total PAEE and daily hours spent at different intensities of PA across transition groups. Results based on Acc and HR monitoring (men). Unpublished and preliminary analyses. Inuit Health in Transition study in Greenland.

Men N=512	Total daily PAEE kJ/kg/day Median (IQR)	MVPA (>3METs) Median hours (IQR)	Moderate PA (3–6METs) Median hours (IQR)	Vigorous PA (>6 METs) Median hours (IQR)	Light PA (1.5–3 METs) Median hours (IQR)
A Hunters/fishermen	69.1 (42.8-77.9)	2.4 (1.3-3.0)	2.1 (1.1-2.5)	0.1 (0.04-0.4)	7.3 (6.1-8.8)
B Other villagers	56.6 (47.5-75.8)	2.2 (1.2-3.2)	1.9 (1.2-2.7)	0.1 (0.01-0.3)	6.8 (5.6-8.1)
C Blue-collar migrants	56.1 (39.9-67.4)	1.9 (1.1-3.0)	1.7 (1.1-2.8)	0.09 (0.01-0.3)	6.7 (4.9-7.5)
D Other blue-collar	58.0 (45.1-75.4)	1.95 (1.3-3.1)	1.8 (1.2-2.8)	0.1 (0.04-0.3)	7.8 (5.5-8.2)
E Intermediate	56.0 (39.8-71.3)	1.9 (1.1-3.1)	1.9 (1.0-2.7)	0.07 (0.01-0.2)	7.0 (5.5-8.0)
F Professionals	52.5 (38.8-62.1)	1.6 (1.2-2.5)	1.5 (1.2-2.5)	0.1 (0.02-0.28)	6.4 (5.0-7.8)
Trend age-adjusted	P=0.046	P=0.3	P=0.3	P=0.08	P=0.2

Table 4. Total PAEE and daily hours spent at different intensities of PA across transition groups. Results based on Acc and HR monitoring (women). Unpublished and preliminary analyses. Inuit Health in Transition study in Greenland.

Women N=690	Total daily PAEE kJ/kg/day Median (IQR)	MVPA (>3METs) Median hours (IQR)	Moderate PA (3–6METs) Median hours (IQR)	Vigorous PA (>6 METs) Median hours (IQR)	Light PA (1.5–3 METs) Median hours (IQR)
A Hunters/fishermen	46.9 (38.1-55.5)	1.4 (1.0-2.1)	1.4 (0.98-1.99)	0.04 (0.007-0.1)	6.8 (6.0-8.3)
B Other villagers	46.4 (34.9-62.9)	1.7 (0.8-2.7)	1.5 (0.8-2.6)	0.06 (0-0.2)	6.7 (5.3-7.9)
C Blue-collar migrants	46.4 (34.9-56.5)	1.4 (0.8-2.2)	1.3 (0.7-2.0)	0.04 (0-0.1)	6.6 (5.5-7.8)
D Other blue-collar	43.3 (32.4-59.1)	1.4 (0.8-2.3)	1.3 (0.8-2.1)	0.04 (0.003-0.1)	6.3 (5.1-7.8)
E Intermediate	47.1 (37.2-59.6)	1.6 (1.1-2.4)	1.5 (1.1-2.3)	0.05 (0.01-0.16)	6.9 (5.5-8.1)
F Professionals	43.0 (34.1-56-6)	1.6 (0.98-2.4)	1.5 (0.95-2.2)	0.06 (0.007-0.2)	6.0 (5.0-7.6)
Trend age-adjusted	P=0.6	P=0.5	P=0.5	P=0.4	P=0.3

Is physical activity energy expenditure associated with glucose metabolism in Greenland?

This is the first study to report on associations between objectively measured PAEE and glucose metabolism among Inuit. Associations between PAEE and fasting insulin, 2-hour insulin, fasting glucose, fat mass, BMI and waist circumference (WC) were found for 1,545 adult Inuit presenting valid data from Acc +HR monitoring (≥48 hours of wear-time). After adjustments for age and sex, only the association with fasting and 2-hour insulin remained significant. Further adjustment for waist circumference revealed that only the association between PAEE and 2-hour insulin was independent of WC. An increase in PAEE, in particular for those participants with the lowest level of PAEE (<35 kJ/kg/day), was associated with a lower 2-hour insulin concentration, indicating a dose-response relation of the amount of PAEE as seen in figure 8; on average, fasting and 2-hour insulin levels were 3% and 9% lower for every 10kJ/kg/day difference in PAEE. This difference could be achieved with an extra hour of gentle walking each day.

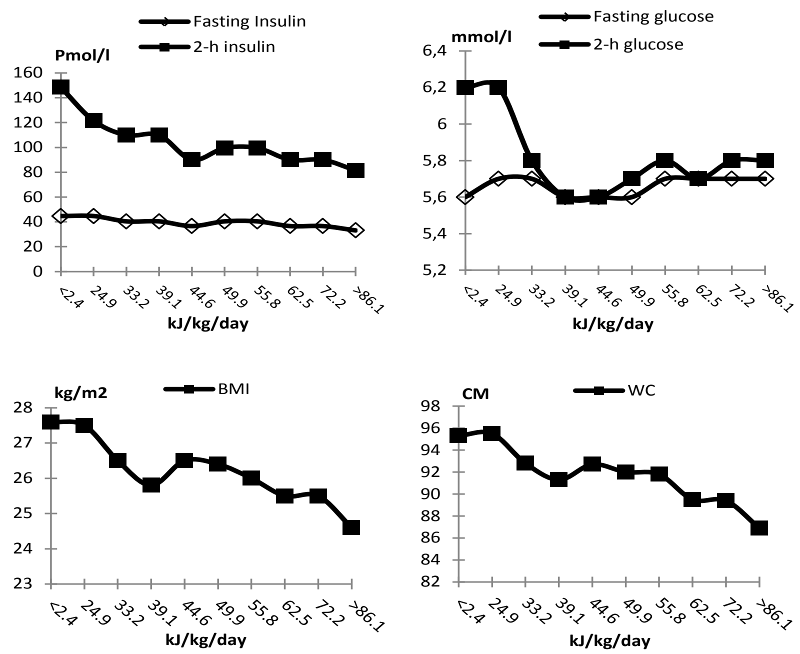


Figure 8. Age- and sex-adjusted means of fasting glucose, 2-hour glucose, fasting insulin and 2-hour insulin, BMI and waist circumference across deciles of PAEE. Inuit in Greenland (n=1545).

Intensities of daily life PA – an overview

Table 5 provides an overview of the Acc and HR measurements and demonstrates that light intensity PA (<3METs) contributed to a substantial part of the daily life PA. In contrast, a very limited amount of time was spent at vigorous intensity PA, but the relative contribution to total PAEE was substantial.

Table 5. Absolute median number of hours spent at different intensities of PA (24 hours) and the contribution of different intensities of PA for total PAEE. Preliminary and unpublished analysis. Inuit Health in Transition study in Greenland.

	Hr/day	IQR	% of total PAEE	IQR
Men (n=568)				
Light intensity (1.5–3 METs)	6.8	5.3-8.1	52.6	42.6–61.1
Moderate intensity (3–6METs)	1.8	1.1-2.7	33.9	26.3–41.9
Vigorous intensity (>6 METs)	0.1	0.02-0.3	4.3	0.8–11.4
Sedentary time (<1.5METs)	14.9	13.0-17.1	4.0	2.1–6.4
Women (n=770)				
Light intensity (1.5–3 METs)	6.5	5.3-7.9	55.8	47.7–64.3
Moderate intensity (3–6METs)	1.5	0.9-2.2	31.4	23.1–39.2
Vigorous intensity (>6 METs)	0.1	0.007-0.2	2.5	0.2–6.8
Sedentary time (<1.5 METs)	15.7	13.7-17.4	5.1	2.7–7.9

Values include all epochs (day and night). Intensity is defined as multiples of RMR, estimated by age, sex, height, and weight (93).

Discussion

The overall aim of this PhD thesis was to study PA patterns in an arctic population undergoing rapid social transition and to add to the epidemiological evidence of how PA relates to glucose metabolism in an Inuit population in Greenland. Moreover, the thesis aimed to study the feasibility of a questionnaire-based measure of PA at a population-based level in Greenland.

Main findings

- The IPAQ-L modified to arctic living conditions and interpreted with truncation of extreme outliers is a moderately valid measure for overall physical activity at population level, but not valid to measure different intensities of PA and sedentary activity when compared with accelerometry and heart rate monitoring (Acc and HR). In particular, moderate intensity is substantially over-reported if walking is included in the measure. However, the questionnaire provides important complementary information on domain-specific PA, which is specifically of interest in populations undergoing rapid social changes, such as Greenland.
- When using residence, education and occupational status to rank the population into six subgroups as a proxy for different stages of social transition, we found that PA patterns differed between transition groups, and we were to some extent able to identify changes in PA patterns in relation to the social transition. Less time was spent on occupational, domestic (women only) and transportation-related PA and more time was spent on sedentary activity among the group of participants in towns, with longer vocational or academic education (more modern lifestyle) compared with hunters and fishermen in villages (more traditional lifestyle). No difference was found for time spent on leisure time PA across transition groups. The overall time spent on PA did not decrease linearly. However, preliminary analyses based on Acc and HR monitoring show that physical activity energy expenditure (PAEE) decreased across the transition groups for men, but not for women. The transition groups only work as a proxy for longitudinal information; hence, changes must be interpreted with caution.
- A strong association was found between objectively measured PAEE and BMI and waist circumference. PAEE and 2-hour insulin only was shown to be associated independently of abdominal obesity. Age, sex and weight were confounding factors for the association between PAEE and fasting glucose, 2-hour glucose and fasting insulin. The results indicate a positive dose-response relation and it is suggested that increasing PAEE, in particular for those participants with the lowest level of PAEE (<35 kJ/kg/day), is associated with a lower 2-hour insulin concentration. Our results suggest that both obesity and low levels of PAEE may be important contributing risk factors for the increasing prevalence of type 2 diabetes among Inuit in Greenland. Nevertheless, the study also points out the importance of examining factors other than lifestyle, i.e. genetic or early-life factors, which could play a role in the development of impaired glucose metabolism.

Is measuring physical activity by questionnaire a feasible method in Greenland?

A valid measure of PA is of great importance for the future monitoring of PA in Greenland. The finding of a moderate agreement between the modified version of IPAQ-L and Acc and HR monitoring in the measure of total PAEE is contrary to several other studies where overestimation of PA by IPAQ has been shown, especially at high levels of PA, a bias for which social desirability has been suggested as a plausible explanation (94-97). The attention from the media on the positive health impact of PA may have been less marked in Greenland compared with more westernized countries, and thus the risk of social desirability bias may be somewhat lower in our study. Moreover we found the IPAQ-L to be valid for use in both towns and villages in Greenland. This is contrary to previous studies demonstrating IPAQ to be less valid in rural areas (57;75;78). According to the interviewers in our study the use of face-to-face interviews undertaken by Greenlandic interviewers most likely have diminished potential interpretational differences between towns and villages in relation to the wide differences in living conditions, climatic differences and dialects across Greenland. Likewise, a status report on the assessment of PA found the use of interviewers to increase the validity of the responses compared with self-reporting (12). Furthermore the adapted examples of PA might have made the reporting of PA easier to report adequately.

Asking for domains of PA makes the IPAQ-L a rather long and time-consuming questionnaire compared with other PA questionnaires. However, our results show that the domain-specific information of PA was highly valuable in Greenland to identify domain-specific differences in PA patterns along with the social transition. Moreover, substantial information from occupational and domestic PA would have been missing if we had measured PA during leisure time only and would have resulted in a substantial lower overall level of PA. Similarly to most other studies, the IPAQ-L substantially overestimated moderate intensity PA in our study. Time spent walking was included in all four domains in the questionnaire, which might have increased the risk of reporting the same walking activity twice. Ekelund and colleagues found that walking is difficult to accurately quantify (98), and studies have shown large errors when assessing simple activities such as walking (13;99). When excluding walking from the analyses we found a substantially better agreement between IPAQ-L and Acc and HR monitoring. According to guidelines from the IPAQ group (89), walking is set to moderate intensity and is assigned the MET value of 3.3 METs. In the compendium of PA by Ainsworth et al, various intensities of walking corresponding to different MET values are listed (2.3 to 3.6METs)(14). One could argue that a slow pace of walking corresponds to light intensity and not moderate intensity. Moreover, qualitative information from the interviewers in our study revealed that occupational activities, such as teaching or working in a shop, were sometimes misinterpreted as walking activity instead of light intensity PA. Walking is very common in Greenland due to an infrastructure with a limited number of roads and cars, as well as small residential areas; therefore, walking might contribute to a substantial misclassification of overall moderate intensity. In addition, the IPAQ, as well as most other questionnaires, does not include questions about light intensity activities which may result in participants classifying light intensity PA as moderate intensity PA. Acc and HR monitoring revealed that light intensity PA contributes to a substantial part of daily life PA. Such error will therefore clearly result in substantial overestimation of moderate intensity PA.

Previous research has shown that in particular activities of light and moderate PA are difficult to recall because these activities often include unstructured activities in contrast to vigorous intensity PA, which includes more structured activities like sports (12;70;99). However, in Greenland we found that questionnaire-based vigorous intensity PA also showed low validity. According to the interviewers, one possible explanation could be that vigorous intensity was sometimes interpreted as psychological demanding instead of physiological demanding despite of the adapted PA examples. Likewise, a study based on cognitive interviews demonstrated that in some cultural settings intensity level was frequently interpreted as emotional or psychological intensity rather than the level of physical effort (100).

The IPAQ-L did not measure light intensity PA and showed low validity for the measure of sedentary behavior in our study. Along with the increasing availability of sedentary and light intensity pursuits, the relative importance of specific levels of intensity on health has been the subject of much current research. Both light intensity PA and sedentary behavior have been related to decreased metabolic health, but the evidence is still limited and conflicting (53;54;56;101-105). Moreover, it is emphasized that differential measurement uncertainty between intensities of PA challenges the interpretation of their relative importance (106).

The IPAQ-L only allows reporting of PA for a minimum duration of 10 minutes. However, as populations are getting more sedentary it could be argued that questionnaires also must take into account short bouts of PA (<10 min) and low intensity PA to avoid the risk of “floor effects”. In statistics, it means that data cannot present a value lower than some particular number, which could hinder the ability to differentiate between low levels of PA (107). This effect might be present in our study. The evidence for a minimum duration of activity to induce health benefits is limited, as is the effect of accumulated versus continuous bouts of exercise. A study by Eriksen et al showed that 3x10 minutes had a greater impact on glycemic control than one bout of 30 minutes (108), whereas a review of empirical studies was not able to make firm conclusions on the effect of continuous versus accumulated exercise on health (109).

In the IPAQ-L, PA is reported from the previous 7 days. The climate in Greenland includes substantial seasonal differences, which could potentially influence the PA level reported and provide differences in PA results relating to when data is collected. In our study, we collected data both in winter and summer time, although villages were only visited during summer time. Further information on seasonal variation would be valuable to include in future measurements of PA in an arctic population. Although, a study of seasonal differences in the level of fitness in an Inuit population found that despite substantial seasonal differences in hunting patterns, fitness remained at a high level throughout the year, with no indication of differences between summer and winter. Similar results were found for Inuit living more permanently in settlements (110).

Overall, we find the modified version of the IPAQ-L to provide important domain-specific information and valid to use in an arctic population to provide an estimate for overall PAEE at population level, but not to distinguish between intensities of PA and sedentary behavior. Furthermore, IPAQ-L does not provide a measure of light intensity PA. In relation to feasibility, we find the questionnaire-based method to have a low participant burden and to minimize reactivity (an individually changing behaviour due to being measured). However, in principle self-reported PA is perceived as a relatively low cost method and therefore often used in population-based studies, but in an arctic context like Greenland, the use of trained bilingual interviewers and a need for a Danish and Greenlandic version of the questionnaire culturally adapted and modified to arctic living conditions, made the questionnaire method rather costly. Moreover, IPAQ-L is very comprehensive and therefore a time-consuming questionnaire, in particular if used for surveillance purpose.

Larger-scale studies have started to combine self-reported measures with device-based measures. In Greenland, the use of combined heart rate and movement monitoring provided us with a unique opportunity to obtain supplemental information on objectively measured PA and intensity level. Although we did not validate the method in Greenland, we obtained comprehensive practical experience of the use of a relatively new method under arctic living conditions and the subsequent data processing (appendix III). We found that both methods contributed with important knowledge on the different dimensions of PA in Greenland. Table 6 presents an overview of what is found to be the main advantages and disadvantages using the two methods in Greenland.

Table 6. An overview of main advantages and disadvantages of using the interviewer-administered IPAQ-L and Acc and HR monitoring in Greenland.

	IPAQ-L
Advantages	››Domain and activity-specific information
	››Information on sedentary time and intensities
	››Limited reactivity
	››Relative high feasibility e.g. logistic and low participant burden
	››Culturally adaptable to arctic living conditions
	››Valid measure for overall PAEE (both villages and towns)
Disadvantages	››Risk of systematic and non-systematic bias (recall Bias, social desirability bias)
	››Limited validity for measuring intensity and sedentary behavior
	››Data processing issues, outliers
	››Context and cultural-dependent
	››Costly (interviewer-administered, language) and time-consuming
	››No measure of light intensity PA

	Acc and HR monitoring
Advantages	››Information of total amount, frequency, duration and individual patterns of physical activity ››Avoiding bias seen by self-report, such as recall bias ››More accurate and precise estimation of individually based PAEE than self-report ››Not prone to recall bias, social desirability bias
Disadvantages	››High participant burden, risk of reactivity ››Resource demanding due to logistic and cost ››Complex data managing, and processing of sensor noise for HR ››Limited information of context and type of PA ››Practical issues (wear time, administration and placement)

What characterizes the physical activity transition in Greenland?

Most of the research on changes in chronic diseases and risk factors in populations undergoing rapid transition has focused on urbanicity (nature of urban environments) measured by a simple dichotomized measure (urban versus rural). The use of an urban-rural dichotomy has been criticized for ignoring the heterogeneity of environments within urban and rural areas and for inability to detect changes over time because rural areas themselves are being modernized (111;112). Modernization in Greenland has resulted in increased mechanization of hunting and fishing activities both in villages and towns. Likewise sedentary service-oriented occupations and sedentary pursuits, such as computer use and TV viewing during leisure time, have not only increased in availability in towns but also in the most remote villages, and walking activity is still very common in both towns and villages. The modernization of both urban and rural areas results in a less clear distinction between urban and rural (Champion and Hugo, 2004), and important differences in the process of urbanization or modernization might be overlooked using this simple variable. In Greenland, various definitions of Westernization have been used. One study defined the degree of Westernization by language and current place of residence (50). Another study used parents' place of birth and occupation, residence during childhood, knowledge of Greenlandic and Danish and school education to divide the population into a group of Greenlanders with a predominantly traditional childhood and a group with a more Westernized childhood (3). In order to obtain more detailed information on the ongoing modernization process in Greenland, we used the participant's current place of residence and childhood residence combined with formal education and family job type as a proxy for secular changes in PA patterns (69). The various definitions of urbanization and modernization also complicate the comparison of the physical activity transition and its consequences between populations and within populations over time. However, most studies worldwide agree that occupational PA has decreased with modernization (52;57;59;60;113), similarly to what we found in our study in Greenland. We showed that for men this decrease was mostly explained by the difference in occupational PA between hunters and fishermen in villages and participants with longer vocational or academic education living in a town. This is most likely explained by more sedentary occupational activities available when higher educational status. In our study, the decrease in transportation-related PA found both for women and men, is most likely explained by the limited possibility for mechanized transport in villages compared with larger towns in Greenland. Furthermore, we found a substantial difference in household PA for women along with the social transition, which for some part might be explained by increasing mechanization of household chores and water facilities, and less time available at home especially among the group of professionals in towns compared with villages. Men spent relatively less time on household PA compared with women across all groups of the transition variable, which might be an expression of social norms rather than a consequence of social transition. In accordance with other populations undergoing transition we found no differences in participation in leisure-time PA in relation to social transition (59;60). This finding is contrary to the upward tendencies found in time-trend studies in Western populations, although only a few exist (113;114). One explanation could be a greater focus on health-enhancing PA, such as weight control and well-being, more time eligible for leisure-time pursuits in Western populations or the question of availability of activities suitable for leisure-time pursuits. Another explanation could be that traditional activities, such as hunting and fishing are being misclassified as occupational activities even though they have increasingly gained status as a leisure activity in Greenland because of the potential overlap of these activities in this cultural context.

The supplemental information from Acc and HR monitoring in our study revealed additional important information on gender differences in relation to social transition. The energy expenditure spent on PA decreased linearly by stages of social transition for men. This decrease seems to be partly explained by decreasing time spent on moderate-to vigorous intensity PA. For women, the overall PAEE and time spent on different intensities of PA was not significantly different. The results indicate that PA patterns have changed as a result of the social transition both for men and women, but had an impact on total PAEE for men only. This finding is in line with a previous study in Greenland that showed an association between Westernization and metabolic risk for men only (50). Knowledge of differences in PA patterns in relation to the modernization process in Greenland can help to differentiate and target the promotion of PA.

We also did the analyses of PA patterns comparing villages and towns as an expression of the traditional urban-rural distinction and found only small differences in PA patterns, which might indicate that more detailed information is obtained using the social transition variable. The transition variable was developed specifically for Greenland and should not be applied to other populations in the Arctic without further examination. Moreover, data are cross-sectional and, therefore, changes in PA can only be seen as a proxy for longitudinal changes.

Research has been done to develop more detailed measures for urbanization. One study used residence and occupation to measure urbanization (115). Another study developed an urbanization index score on the basis on ten measures both at individual level and area level: population size, population density, access to markets, transportation, communication possibilities, economic factors, housing quality, education, sanitation and health (116). Dahly et Adair constructed a multivariable scale of urbanicity using community level data: population size, population density, communication possibilities, transportation, educational facilities, health services and markets. The scale was shown to be able to detect differences in urbanicity between communities and across time (111). It would be valuable to examine if some of these variables, such as ownership of different assets, economic factors as level of income and access to communication and transportation facilities could provide more insight in the process of modernization in Greenland.

Physical activity and glucose metabolism in Greenland - what is the evidence?

The inverse association between PAEE and 2-hour insulin independent of abdominal obesity found in our study is in line with findings from other populations undergoing rapid social transition (48;52;117). The indicated dose-response relation between the volume of PAEE and 2-hour insulin, in particular for those participants with the lowest level of PAEE, corresponds well with research suggesting a positive dose-response effect of total PA on health (23;24) and that even small increases in PA among the most physically inactive is shown to be beneficial for health (22). However, the results must be confirmed in future prospective studies. Contrary to most previous research, we were not able to identify an association between PAEE and 2-hour plasma glucose and IGT when measurements of abdominal fat were included in the analysis (48;51;118;119). However, not all studies have included body composition measures as potential confounding or mediating factors. Research examining the patho-physiology and aetiology of impaired glucose tolerance (IGT) showed that IGT was predominantly related to physical inactivity, unhealthy diet and short stature (120). Although, we adjusted our analysis for factors known to be related to both PA and glucose metabolism outcomes, such as age, sex, smoking and family history of type 2 diabetes, residual confounding might be present. For example, diet, early life factors or genetic disposition not captured by family history, which we were not able to adjust for, could play a significant role in our population. A study found fasting glucose to be a marker of beta-cell dysfunction and hepatic glucose production rather than peripheral insulin resistance, and predominantly related to genetic factors, smoking and male sex which could be a plausible explanation for our findings for PAEE and fasting glucose (120).

Insufficient physical activity may contribute to impaired glucose tolerance through a pathway including alterations in obesity and fat distribution. Our regression analysis showed that abdominal fat was significantly associated with glucose and insulin concentrations and that PAEE was inversely associated with BMI, waist circumference and fat percentage. It is suggested that overweight or obesity have a significant role in explaining differences in 2-hour insulin and fasting insulin in our study population. A study of Rana et al. demonstrated that obesity and physical inactivity contributed to the development of type 2 diabetes independently; however, the magnitude of risk contributed by obesity was much greater than the lack of PA (121). The evidence of the relative influence of obesity and physical inactivity on the risk of developing diabetes is however still sparse and conflicting. A Finish study found that increasing PA was associated with a significantly reduced risk of type 2 diabetes, especially among obese patients (122). Contrary, Weinstein and colleagues concluded that PA had relatively small effects on diabetes in overweight and obese patients (123). Our results suggest that both obesity and low levels of PAEE may be important contributing risk factors for the increasing prevalence of type 2 diabetes among Inuit in Greenland. Nevertheless, the study also points out the importance of examining other factors, than just those related to current lifestyle, such as genetic or early life factors, which could play a role in the development of impaired glucose metabolism in this indigenous population. Findings in this thesis can be incorporated in public health strategies in the prevention of type 2 diabetes in Greenland. However, the cross-sectional design does not allow us to draw conclusions about the direction of associations or any strong inference on causality.

Methodological considerations

Strengths

Some strength of the three studies should be put forward. The validation study is based on a large study sample (n=1508) encompassing all fractions of the population, which is contrary to most validation studies based on a small number of participants. Such a sampling strategy for validation increases the probability that all possible interpretations and lifestyles are included, and forces one to think about how to deal with outliers without introducing too much selection bias (paper I). The social transition variable provided us with the possibility to obtain a proxy for the physical activity transition when longitudinal data were not available (paper II). The association between PAEE and glucose metabolism has mostly been studied by the use of self-reported measures. We used an objective measure for PAEE. Furthermore, the measures of glucose tolerance and insulin concentrations were based on blood samples instead of self-reported measures of type 2 diabetes (paper III). However, the three studies also present several potential limitations, of which the main are discussed in the following.

Selection Bias

The Inuit Health in Greenland study demonstrated a participation rate of 66.7%, which is high compared with population-based surveys in general (124), and especially for this setting where data collection is challenged by infrastructure and weather conditions. Moreover, the study surveyed a large proportion of the adult, Greenland born population (9.2%). However, we have very limited information on the non-participants, and therefore the risk of selection bias cannot be ruled out; some potential differences between participants and non-participants should be emphasized in relation to the existence of possible selection bias. The variation in participation rates across the country and between villages, towns and the capital and the stratification procedure of the random sample means that the study sample includes proportionately more participants from some regions despite their small percentage of the total population. Because of logistic challenges it would be almost impossible and costly to base this population survey on a non-stratified sample. The non-random distribution of non-participants could introduce bias for the precision of countrywide estimates.

There are several potential explanations for non-participating in the study. The rather long duration of the health examination, including both clinical and questionnaire measurements, could be an explanation for the higher proportion of non-participants from the larger towns compared with villages due to a more busy daily life. This scenario is underlined by a higher proportion of participants in Nuuk indicating lack of time as the reason for not wanting to participate (17% of the non-participants compared with 2% in the rest of the communities). We suspect that socially exposed persons, alcohol abusers and persons who frequently go in and out of jobs and the unemployed likewise are over-represented among the non-participants. It was the impression of the interviewers that there was a distinct downward social trend from the beginning to the end of data collection in a town. In some towns it could be demonstrated that during the first week of the study in a particular community 10% of those who had made an appointment did not show up, while during the last week of the study as many as 26% failed to show up. Analyses of register-based income showed that the personal income of participants was higher than among non-participants, which confirms this possible social selection. However, we find it unlikely that this selection would have affected the association between PA and glucose metabolism. There is a potential risk that hunters and fishermen are underrepresented in this study due to longer periods of time being away from home and therefore not being present at the health examination. It is difficult to evaluate the effect of such selection; however, as shown in paper II this group is most physically active, and therefore such a selection could bias the population estimate of PA.

We know that persons with serious illness or disability are overrepresented among the non-participants; this bias might play a role for the ability to generalize the estimates of median PA to the population as a whole (106). However, we find it unlikely that this bias would have affected the validity of the association between physical activity and glucose metabolism within this population. The participants differed from non-participants by age and sex. Women more often participated than men, and particularly young men were under-represented. A lower proportion of young participants will most likely be accompanied by a higher prevalence of type 2 diabetes but also of a lower level of PA. Since our sample did include some young participants, it is unlikely that this bias will alter the age- and sex-adjusted association between PA and glucose metabolism in this thesis.

Papers I and III are based on a reduced subsample (n=1545) due to a limited number of participants with accelerometry and heart rate monitoring. The subsample was selected from all over Greenland, and only small differences were found between the subsample and the total study sample (further details in appendix III). The odds for being monitored by ACC and HR did not differ significantly between sexes, was slightly lower only for age groups above 70 years and 40-44 years old and for participants living in a town, but was higher for participants living in Nuuk. Overall, we have no reason to believe that the association between PAEE and diabetes should be prone to substantial selection bias.

Information bias and validity of the physical activity measurements

Misclassification in relation to the level and dimension of physical activity is likely when using self-reported methods. Social desirability is a plausible explanation for misclassification due to over-reporting of PA by self-report (12). The moderate agreement between the two methods for overall PAEE may imply that the risk of non-differential misclassification due to social desirability bias may be somewhat lower in our study. Physical activity is a multidimensional behaviour and therefore most likely prone to recall bias. Structured activities, such as type of exercise, have been shown to be easier to recall compared with activities like walking and other moderate-intensity activities, which are seldom structured (12). This could explain the highly overestimated level of moderate intensity and walking in paper I (non-differential misclassification). The IPAQ asks about PA in the previous 7 days. Studies have shown that this time limit is easier to remember compared with monthly averages (70), and it therefore lowers the risk of recall bias in our study. Individual characteristics, such as level of fitness, could possibly play a role in the perception of intensity, e.g. individuals with a higher level of fitness may perceive moderate (3-6 METs) and vigorous activity (>6 METs) differently compared to those who are more sedentary, providing a potential differential misclassification of self-reported PA.

The use of device-based measures of PA in paper III avoids issues of recall bias (88;125).
However, contrary to the estimates from the IPAQ-L calculated as the average of the previous 7 days (no information on sleeping hours, but 8 hours were estimated for sleep), the estimation of physical activity energy expenditure from ACC and HR monitoring was based on individual recordings from 48 hours to 5 full days mostly representing both week and weekend days. Rennie et al. estimated that 3 days of recording yielded a validity coefficient of 0.85 for the assessment of energy expenditure in a European sample (126). In our study, only 858 of the participants had more than 3 days of wear data, but our sensitivity analyses showed similar results when applying this stricter inclusion criterion. Ideally, more days of objective recording would have been preferable to capture variations in PA during the week, but logistics made this unfeasible.

As a consequence of the administration of the two instruments they did not refer to the same time period. The monitor was given to the participants on the day they were interviewed about their PA in the preceding 7 days. However, the short interval between the periods is unlikely to have introduced substantial bias in the results, and one may even consider the present results to reflect more truly the convergent validity of these instruments to assess habitual physical activity. In the interpretation of validity it is crucial which reference method is chosen as criterion measure. The ACC and HR monitoring in this study has shown itself to be valid compared with DLW in a non-Western context (86)). Another crucial factor is whether the two methods measure different aspects of PA. The IPAQ asks for PA of moderate or vigorous intensity for a minimum of ten minutes, and no information on sleep is available, whereas the device-based method provides estimates of PA for 24 hours including all PA intensities. This provides a potential bias in the estimates of especially different intensities of PA during an average day estimated by IPAQ-L.

Confounding

The multiple linear regressions between PAEE and glucose metabolism in paper III were adjusted for potential confounders/mediators identified a priori based on identification from previous research of risk factors for type 2 diabetes and biological plausibility: sex, age, smoking, family history of diabetes and waist circumference. Still, there is a risk of residual confounding, or confounding due to unmeasured covariates, which could skew the association between PAEE and glucose metabolism in our population, such as diet, early life factors or genetic disposition not captured by family history, which we were not able to adjust for. Contrarily, also a potential risk of over-adjustment is present if considering waist circumference as a confounder and not a mediator for the association between PAEE and glucose metabolism. In paper II differences in time spent on physical activity across social transition were analyzed in linear regression model with time spent on PA as dependent variable. The analyses were age adjusted and stratified by sex.

Causal relationship

The cross-sectional design of the study did not allow us to make conclusions about the direction of associations or any strong inference on causality. There is a potential risk of reversed causality if participants with type 2 diabetes have a lower level of PA due to type 2 diabetes-specific complications. We tried to minimize this by excluding participants with known diabetes from the analyses.

Conclusion

The beneficial effects of physical activity (PA) on glucose metabolism are well-established in Western populations. The knowledge is, however, much more limited when it comes to populations undergoing rapid social transition, such as Inuit in Greenland. It has been suggested that decreasing PA is an important contributing risk factor for the increasing prevalence of type 2 diabetes in this population.

The work presented in this thesis shows that physical activity energy expenditure (PAEE) is associated with 2-hour postload insulin independent of abdominal obesity. A dose-response relation indicates a statistically significant beneficial effect of increasing PAEE, in particular for those participants with the lowest levels of PAEE. However, age, sex and waist circumference were confounding factors for the association between PAEE and fasting glucose, 2-hour glucose and fasting insulin. PAEE was strongly associated with BMI and abdominal obesity. Our results suggest that both obesity and low levels of PAEE may be important contributing risk factors for the increasing prevalence of type 2 diabetes among Inuit in Greenland. Nevertheless, the study also points out that other factors, such as genetic predisposition and early life-factors, must play a role for the high prevalence of type 2 diabetes in Greenland. Due to the cross-sectional data in this thesis, causality cannot be established and the association should be further investigated in prospective studies.

The physical activity patterns in Greenland have changed markedly along with the social transition. By grouping the population into stages of social transition we were able to identify information of PA patterns along with the modernization process. A lower level of occupational, domestic and transportation-related PA was found among professionals in towns (most modern lifestyle) compared with hunters and fishermen in villages (most traditional lifestyle). Nonetheless, no difference in leisure time PA was found as a result of the social transition. Leisure time PA could be an important domain for the promotion of PA in order to prevent decreasing levels of overall PA along with the ongoing social transition. Despite the difference in PA patterns, the overall PAEE decreased by stages of social transition for men only, this is most likely explained by decreasing time spent at moderate to vigorous intensity PA. However, due to the cross-sectional design of the study, changes can only be seen as a proxy for longitudinal changes.

Surveillance of changes in PA is of great importance due to the increasing metabolic disorders reported in Greenland. We find the modified interviewer-administered IPAQ-L as a valid method to measure overall PAEE but it cannot be used to differentiate between intensities of PA. Furthermore, the method is feasible to use in Greenland but the interviewer-administered version, which seemed to be important to prevent cultural barriers in the interpretation of the questions made the questionnaire-based measurement of PA relatively costly and time consuming. Furthermore the lack of information on light intensity PA, shown to be contributing to a large part of daily life PA, must be considered if this measurement tool is to be used. In Greenland, the use of combined heart rate and movement monitoring provided a unique opportunity to obtain supplemental information on objectively measured PA and intensity level and is feasible to use in an arctic setting, although the method is still costly, and logistically as well as technically demanding.

Implications for public health in Greenland

The promotion of a physically active lifestyle in Greenland played a central role in the public health program Inuuneritta 2007-2012. Our findings underline the need to continuously include PA in prevention and promotion strategies, such as the Inuuneritta 2013-2016, in order to maintain and promote a physically active lifestyle in relation to the ongoing process of modernization. The suggested dose-response relation of physical activity energy expenditure (PAEE) on a precursor for type 2 diabetes, with benefits for those with the lowest level of PAEE in particular, is an important public health message in the future prevention of type 2 diabetes.

The difference in PA patterns in relation to the process of modernization indicates the necessity of targeting the promotion of PA to specific population groups, age-groups and gender. Our results suggest that inhabitants in towns with a longer vocational or academic education are one important group. The domain-specific information on PA in our study points at leisure time as an important domain to promote PA in order to maintain or increase PA. Furthermore our findings suggest a need to focus on reducing time spent on sedentary behaviors. Evidence for negative health consequences of prolonged sitting, such as increased metabolic risk has increased (104;105;127) and even small breaks in the sedentary time have shown beneficial effects on metabolic risk (128). However, controversies still exist whether to include quantitative recommendations or just advise against reducing sedentary behaviors in national recommendations for PA.

Systematic surveillance of PA and sedentary behavior should be carried out in order to monitor time trends and changes in PA patterns along with the social, cultural and economic changes in Greenland. This surveillance should be based on valid methods and comparable measurements. Our findings, illustrate that the combination of a self-reported and a device-based method provides several advantages, such as measurements of domain-specific PA with great importance for providing a valid measurement of the overall PAEE and time spent at different intensities of PA.

Implication for future research

The association between objectively measured PA and glucose metabolism has not been investigated before in an Inuit population and only rarely in other populations. The association must be examined in a prospective design to explore whether the dose-response relation can be confirmed. Furthermore the association between social transition, PA patterns and metabolic risk should be further investigated with the use of objective measures for PA. The contribution of insufficient PA to impaired glucose metabolism through a pathway including alterations in obesity and fat distribution should also be investigated further using data from the Inuit Health in Transition study in Greenland. Data from the Inuit Health in Transition study in Greenland 2005-10 provides the opportunity to study this association in future studies and knowledge about these associations is of great importance for evidence-based-guidelines for PA.

The influence of various levels of intensity (light to vigorous intensity) and domains of PA on glucose metabolism was not investigated in this study. In a future perspective the domain-specific information can be used to study the association between leisure time PA and metabolic health. E.g., a study in a Danish population, found opposing effects of occupational and leisure-time physical activity on global health (129). It has been suggested that a large part of the effect of PA in decreasing insulin resistance is short lived and therefore the effect may last only a few days (130;131). In order to learn more about the underlying mechanism for the association between PA and glucose metabolism in Greenland, the consistency of an individual´s PA could be further assessed by measuring PA more frequently (132).

In order to reduce misclassification of PA by self-report, future studies with a qualitative approach should be carried out examining the concepts of physical activity and different intensities of PA. Such an approach would contribute to further knowledge of the interpretation of physical activity in an arctic setting and also contribute to the further development of appropriate activity examples in questionnaires.

Further research is still needed to increase knowledge on suitable methods to measure PA. The rapid technological development in device-based measurements means that device-based methods are becoming better to integrate context-specific information on PA by using methods, such as Global Positioning System (GPS), Geographical Information System (GIS) and integrated cameras in the monitoring programs (133). These methods might provide valuable information on patterns of PA, and should be investigated for future use in populations-based studies in the Arctic.
Overall there is a lack of knowledge on what motivates or hinders populations in the Arctic to be physically active (134). There is a need for more intervention studies to form the basis for successful PA promotion strategies. Environmental and policy interventions are based on ecological models of behavior and have shown to have a potential to affect the entire population. Cross-sectional data indicate that environmental and policy variables are associated with physical activity behaviors of young people and adults (135). Sallis and colleagues concluded that PA in the different domains of daily life, such as occupation and transport are associated with different environmental factors (136). The influence of environmental and policy factors on PA in Greenland is a subject that deserves much greater exploration and considerations. Furthermore, there is a lack of large-scale studies with comparable data on PA to study the physical activity transition and implications for type 2 diabetes among indigenous populations in the Arctic. Collaborative work should be established in order to develop comparable and standardized measurements as well as survey procedures for cross-country comparisons of PA among indigenous populations in the Arctic. Comparisons of prospective data across populations would provide knowledge on successful intervention and prevention strategies. Already existing data on combined accelerometry and heart rate monitoring among Alaska natives are promising in order to increase the knowledge about PA in the Arctic. Overall, measuring PA in different contexts can help us to clarify how economic and social conditions, as well as the environmental and cultural context within the specific country and across countries play a role for the physical activity transition.

Summary

Since the 1940s indigenous populations in the Arctic, including Greenland, have undergone rapid cultural, economic and social changes characterized by a shift from a traditional lifestyle to a more westernized lifestyle, especially in the larger towns. This process has resulted in a less physically demanding lifestyle with changes from subsistence hunting and fishing to sedentary occupational activity and increased mechanization of society. Parallel to these changes a decrease in infectious diseases and an increase in lifestyle-related chronic diseases, such as type 2 diabetes has been observed. Changes in physical activity patterns are suggested to be an important contributor to the rise in chronic lifestyle diseases. However, little is known about physical activity in arctic populations and how physical activity is related to social and cultural changes in society, the so-called physical activity transition.

The main objective of this thesis was to examine the physical activity transition and the relation to glucose metabolism in an arctic population undergoing rapid social transition. Moreover the aim was to study the feasibility of a questionnaire-based measurement of PA at a population-based level in Greenland. The overall objective was divided into three specific research objectives:

- to validate a modified version of the long International Physical Activity Questionnaire against accelerometry and heart rate monitoring in an arctic population (Paper I).
- to study physical activity pattern in relation to the social transition among Inuit in Greenland (Paper II).
- to analyze the objectively measured association between physical activity energy expenditure and glucose metabolism in Greenland (Paper III).

This thesis is based on data from the Inuit Health in Transition Study (IHT) in Greenland collected in 2005-2010. Data are collected from 9 towns and 13 villages in different parts of Greenland and comprise clinical examinations, and an interviewer- and self-administered questionnaire. The overall participation rate was 64.9%. In total 3102 adult Inuit, aged 18 years and above, were interviewed. The International physical activity questionnaire (IPAQ-long version) was used to obtain data on physical activity (PA) and a subgroup of participants was monitored by combined accelerometry and heart rate monitoring (n=1995).

In the first paper, we found that the IPAQ-L adapted to arctic living conditions in Greenland showed a moderate level of agreement with combined accelerometry and heart rate monitoring for total Physical Activity Energy Expenditure (PAEE) at population level, but was less valid to measure different intensities of PA and sedentary behavior. Validity did not differ markedly between rural and urban communities.

In the second paper, we identified changes in physical activity patterns in relation to the social transition evaluated as differences between groups of social change defined by residence, occupation and education. Men in the latest stage of the social transition spent less time on occupational PA and women less time on

domestic PA, compared with men and women in the earliest stage of the social transition. A similar pattern was found for physical activity in the transportation domain and sitting time for men and women. No differences were found for leisure time PA. The overall time spent on PA was not found to decrease; however physical activity energy expenditure (PAEE) decreased for men only. Due to cross-sectional data, changes must be interpreted with caution.
In the third paper, we revealed that only the association between objectively measured PAEE and 2-h insulin was independent of obesity. Age, sex and waist circumference were confounding factors for the association between PAEE and fasting glucose, 2 hour glucose and fasting insulin. The results underline a need to examine additional potential risk factors in the prevention of type 2 diabetes in Greenland.

This thesis underlines the importance of a continuous monitoring of changes in physical activity in relation to the economic, cultural, and social changes in Greenland. The use of combined heart rate and movement monitoring provides a unique opportunity to obtain supplemental information on objectively measured PA and intensity level and is feasible to use in an arctic setting. From a public health perspective it is important to promote PA during leisure time and reduce sedentary behavior to maintain a physically active lifestyle thereby reducing the development of type 2 diabetes in Greenland.

Dansk resumé

Siden 1940´erne har oprindelige folk i Arktis, herunder Grønland, gennemgået en hurtig kulturel, økonomisk og social forandring karakteriseret ved et skift fra en traditionel livstil til en mere vestlig moderne livstil. Forandringen har især fundet sted i de større byer. Ændringen fra et selvforsørgende fanger og fisker samfund til et samfund, der i højere grad er præget af stillesiddende aktiviteter har medført en mindre fysisk krævende livstil. Sideløbende med disse forandringer er der fundet en høj forekomst af livstilsrelaterede kroniske sygdomme som type 2 diabetes. En ændring i det fysiske aktivitets mønster anses for at bidrage væsentligt til stigningen i de kroniske livstilssygdomme. Der eksisterer kun sparsom viden om fysisk aktivitet og om hvordan fysisk aktivitet relaterer sig til de sociale, økonomiske og kulturelle forandringer, også kaldet den fysiske aktivitets transition.
Det overordnede formål med afhandlingen var at undersøge den fysisk aktivitets transition og sammenhængen mellem fysisk aktivitet og glukose metabolisme blandt et repræsentativt udsnit af inuit i Grønland. Endvidere var formålet at undersøge anvendeligheden af et spørgeskema til at måle fysisk aktivitet i en arktisk kontekst. Afhandlingen havde tre delformål:

- At validere the long International Physical Activity Questionnaire tilpasset arktiske levevilkår sammenholdt med kombineret accelerometri og hjerterytme måling (artikel I).
- At undersøge det fysiske aktivitetsmønster i relation til den sociale transition i Grønland (artikel II).
- At analysere associationen mellem fysisk aktivitet og glucose metabolisme i Grønland målt ved en objektiv metode (artikel III).

Afhandlingen er baseret på data fra Befolkningsundersøgelsen i Grønland (Inuit Health in Transition Study) indsamlet i perioden 2005-2010. Data er indsamlet i 9 byer og 13 bygder i forskellige dele af Grønland og omfattede kliniske undersøgelser, et interviewerbaseret spørgeskema samt et selvudfyldt spørgeskema. I alt blev 3102 voksne Inuit (>18 år) interviewet. Den overordnede deltagerprocent var 64.9%. En modificeret udgave af The International Physical Activity Questionnaire (IPAQ-L) blev brugt til at indsamle data omkring fysisk aktivitet. Endvidere indgik målinger af kombineret accelerometri og hjerterytme (Actiheart®) fra en subgruppe af deltagerne (n=1995).

Afhandlingen viser, at IPAQ-L er anvendeligt til at måle det totale energiforbrug brugt på fysisk aktivitet på befolkningsniveau både blandt by- og bygdebefolkningen i Grønland, men ikke til at differentiere mellem tid brugt på forskellige intensiteter af fysisk aktivitet og stillesiddende adfærd.
Spørgeskemaet giver vigtig information omkring det fysiske aktivitetsmønster og afhandlingen viser, at mønstret har ændret sig i takt med den sociale transition i Grønland målt ud fra en gruppering af bopæl, erhverv og uddannelse. Mænd med længerevarende uddannelse og bosiddende i en by var mindst fysisk

aktive i deres arbejde og kvinder tilsvarende mindst fysisk aktive i hjemmet sammenlignet med mænd og kvinder med en mere traditionel livsstil med bopæl i en bygd. Et tilsvarende mønster blev fundet for den transportrelaterede fysiske aktivitet og for stillesiddende aktivitet både for mænd og kvinder. Der var ingen forskel at finde for fysisk aktivitet i fritiden. Den overordnede tid brugt på fysisk aktivitet ændrede sig ikke i takt med den sociale transition, hvorimod foreløbige analyser viste, at det samlede energiforbrug brugt på fysisk aktivitet faldt for mænd. Studiets tværsnitsdesign betyder at ændringer i fysisk aktivitetsmønster må fortolkes med forsigtighed.

Afhandlingen viser endvidere en sammenhæng mellem energiforbruget forbrugt på fysisk aktivitet og insulin koncentrationen to timer efter efter en oral glukose tolerance test uafhængig af abdominal fedme. Denne sammenhæng kunne ikke genfindes for faste glukose, 2 timers glucose, faste insulin og type 2 diabetes. Resultaterner tyder på, at fysisk aktivetet har en betydning for type 2 diabetes, men at der er behov for at undersøge yderligere risikofaktorer der kan have betydning for udviklingen af type 2 diabetes i Grønland. Denne afhandling understreger betydningen af fortsat at måle udviklingen i fysisk aktivitet i Grønland i takt med den økonomiske, kulturelle og sociale transition. Kombinationen af spørgeskemadata og data fra en kombineret accelerometer og hjerterytme monitor gav værdifuld information om forskellige dimensioner af fysisk aktivitet og var anvendelig i en arktisk kontekst. I et folkesundhedsperspektiv er det væsentligt at fremme fysisk aktivitet i fritiden og reducere stillesiddende adfærd i forhold til at bibeholde en fysisk aktiv livsstil og for at bidrage til forebyggelsen af type 2 diabetes i Grønland.

Grønlandsk resumé

Kalaallisut eqikkaaneq

Issittumi nunap inoqqaavi, tassungalu ilanngullugu Kalaallit Nunaat, 1940-kunnili kulturikkut-aningaasaqarnikkut- inuiaqatigiinnilu inooriaatsimikkut atugaat, sukkasuumik allanngoriartorsimapput, tamannalu ilisarnaatigisimavaa inooriaatsikkut mutiusumik, nunani kippasissuni assingusumik inooriaaseqalersimaneq. Illoqarfinni annerusuni inooriaatsikkut allanngorneq annertuneq pisimavoq. Inuiaqatigiit piniartutut aalisartutullu imminut napatissimasuniit, ullumikkut issianerulluni suliaqartalernerup nassatarisimava, timimik minnerusumik atuinermik inooriaaseqalersimaneq. Allanngornerit taakku saniatigut anigorsinnaanngisanik nappaatinik, soorlu inooriaatsimut attuumassutilimmik sukkorneq annertuumik nassaarfiusimavoq. Timimik atuisarnerup allanngorsimanera, inooriaatsimut attuumassutilinnut nappaatit amerlisimanerannut peqqutaaqataasorineqarpoq. Timip atortarnerannut, qanorlu inuiaqatigiinni inooriaatsikkut- aningaasaqarnikkut- kulturikkullu imminnut attuumassuteqarnersut ilisimasagut annikipput, tamanna aamma timip atortarneranut atatillugu allanngoriartorneranik (transition) taaneqartartoq.
Ilisimatuutut allaatigisap matuma anguniagaa pingaarneq tassaasimavoq, Kalaallit Nunaani kalaallit akornanni, timip atortarnerata allanngorsimanera, saniatigullu timip atortarnera, timimi sukku suliarineqartarneranut atatillugu qanoq sunniuteqarnersoq. Taassumalu saniatigut immersugassaq tunngavigalugu apeqqutit issittumi naleqqunnersut paasiniarlugit. Ilisimatuutut allaatigisaq pingasunik siunertaqarpoq.

- Timip atortarnerannut immersugassaq tunngavigalugu apeqqutit, the long Physikal Activity Questionaire, issittumi inooriaatsimut atorsinnaaneri, timillu atortarnerannut uummatillu tillernerannut uuttuut ataqatigiitsillugit naliliiffiginssaat (allakkiaq I)

- Kalaallit Nunaanni timip atortarnera inuiaqatigiinni inooriaatsimut atatillugu allanngorsimaneranut misissuineq (allakkiaq II)

- Kalaallit Nunaanni timip atortarnera, timimi sukku suliarineqartarnerannut qanoq sunniuteqarnersoq (allakkiaq III)

Ilisimatuuttut allaaserisaq 2005 – 2010-mi Kalaallit Nunaanni innuttaasunik misissuinermit paasissutissanit tunngaveqarpoq (Inuit Health in Transition Study). Paasissutissat illoqarfinni 9-ni nunaqarfinnilu 13-ni tunngaveqarput, tassanilu timikkut misissuinerit, apersuinermi immersugassat, namminerlu apeqqutit akisassat, katillugulu kalaallinit inersimasunit (>18 ukiullit) 3102-t peqataaffigineqarsimalluni. Nuna tamakkerlugu peqataasut 64,9%-iupput. Apersuinermik immersugassaq naleqqussagaq, The International Physical Activity Questionaire (IPAQ-L) timip atortarnerannut paasissutissanik katersuinermi atorneqarpoq.

Saniatigut misissuinermi peqataasut ilaannut (n= 1995) timip atortarnerannut uummatillu tillernerannut uuttuut atorneqarsimalluni.

Ilisimatuutut allaatigisap innutaasunut illoqarfinni nunaqarfinnilu najugalinnut IPAQ-L tamakkiisumik, timip atortarnerannut nukinik atuinermi uuttuutissatut atorneqarsinnaasoq takutippaa, kisiannili timi atorneranut- issiallunilu suliaqarnermut piffissamik atukkamik immikkoortitsinermi atorneqarsinnaanani. Apersuinermi immersugassaq pingaarutilinnik timimik atuisarnermut takussutissanut paasissutissiivoq, ilisimatuutullu allaatigisap Kalaallit Nunaanni sumiissuseq- inuutissarsiut ilinniagaqarnerlu aallaavigalugit inuiaqatigiinni inooriaaseq allanngorsimanera ilutigalugu timimik atueriaaseq allanngorsimasoq takutippaa. Angutit sivisunerusumik ilinniagallit illoqarfimmilu najugallit, suliffimmini timimik atuinnginnerupput, arnat taamatulli angerlarsimaffimmini timimik atuinnginnerullutik, arnanut angutillu nunaqarfinni najugalinnut ileqqutoqqat malinnerullugit inooriaasilinnut sanilliullugit. Tamanna aamma angallassinermut atatillugu timimik atuisarnermut issiaanernerusumillu suliaqarnermut arnat angutillu akornanni takussaavoq. Suliffiup avataatigut timimik atuisarnermut atatillugu immikkooruteqanngilaq. Tamakkiisumik timip atortarneranut piffissaq atugaq, inuiaqatigiinni inooriaatsip allanngorsimanera aallaavigalugu allanngoriartunngilaq, illuatungaanili misissuinerit siulliit timimik atuinermi nukinik atuineq angutit akornanni apparsimasoq takutippaat. Misissuinerup ilusilersornera pissutigalugu timimik atuisarneq allanngorsimaneranut naliliinissaq mianersortumik pissaaq.
Saniatigut ilisimatuuttut allaaserisap timip atornerannut atatillugu, nukinik atuineq insulin aammi kimittussusaa, sukkornermut misissuinermut atatillugu sukkutorsimanerup nalunaaqutaq marluk kingunerini, naakkut orsoqassusermut atuumassuteqanngitsoq. Tamannalu assigisaanik sukkornermut misissuinermut atatillugu sukkutorsimanerup kingorna akusiuinikkut ((faste glucose, 2 timers glucose, faste insulin type 2 diabetes-ilu) takussaasimanani.
Misissuinerup inerneri timip atortarnera inooriaatsimut tunngasumik sukkornermut attuumassuteqarsinnaasoq takutippaa, kisiannili sukkornermut pilersitsisartut allat aamma Kalaallit Nunaanni misissorneqarnissaat pisariaqarpoq. Ilisimatuut allaaserisap matuma timip atortarnera, qanoq ineriartornera Kalaallit Nunaanni aningaasaqarnerup- kulturikkut- inuiaqatigiinnilu inooriaatsip allanngoriartornera ilutigalugu, uuttortarneqarnissaa pingaaruteqarnera naqissuserpaa. Apersuinermi immersugassat, timip atortarnerinut assigiinngitsunut, uummatillu tillernerannut uuttuut pingaarutilinnik paasissutissanik pissarsiffiuvoq, issittumilu atorneqarsinnaallutik. Innuttaasut peqqissuunissaannut atatillugu, sunngiffimmi timip atortarnissaannut kaammattuinissaq pingaaruteqarpoq, issiaannarlunilu suliaqartarneq annikillisarnissaa, taamaalilluni inooriaatsimut atatillugu sukkortarnermut pitsaaliuinissamut tapertaasinnaalluni.

Reference list

(1) Bjerregaard P, Young TK, Dewailly E, Ebbesson SO. Indigenous health in the Arctic: an overview of the circumpolar Inuit population. Scand J Public Health 2004;32(5):390-5.

(2) Jørgensen ME, Bjerregaard P, Borch-Johnsen K. Diabetes and impaired glucose tolerance among the inuit population of greenland. Diabetes Care 2002;25(10):1766-71.

(3) Bjerregaard P, Mulvad G, Pedersen HS. Cardiovascular risk factors in Inuit of Greenland. Int J Epidemiol 1997;1;26(6):1182-90.

(4) Chateau-Degat ML, Dewailly E, Louchini R, Counil E, Noel M, Ferland A, et al. Cardiovascular burden and related risk factors among Nunavik (Quebec) Inuit: insights from baseline findings in the circumpolar Inuit health in transition cohort study. Can J Cardiol 2010;26(6):190-6.

(5) Hopping BN, Erber E, Beck L, De Roose E, Sharma S. Inuvialuit adults in the Canadian Arctic have a high body mass index and self-reported physical activity. J Hum Nutr Diet 2010;23 Suppl 1:115-9.

(6) Hopping BN, Erber E, Mead E, Roache C, Sharma S. High levels of physical activity and obesity co-exist amongst Inuit adults in Arctic Canada. J Hum Nutr Diet 2010;23(suppl. 1):110-4.

(7) Redwood D, Schumacher MC, Lanier AP, Ferucci ED, Asay E, Helzer LJ, et al. Physical activity patterns of American Indian and Alaskan Native people living in Alaska and the Southwestern United States. Am J Health Promot 2009;23(6):388-95.

(8) Young TK, Katzmarzyk PT. [Physical activity among aboriginals in Canada]. Appl Physiol Nutr Metab 2007;32 Suppl 2F:S165-S178.

(9) Findlay LC. Physical activity among First Nations people off reserve, Metis and Inuit. Health Rep 2011;22(1):47-54.

(10) Rode A, Shephard RJ. Physiological consequences of acculturation: a 20-year study of fitness in an Inuit community. Eur J Appl Physiol Occup Physiol 1994;69(6):516-24.

(11) Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep 1985;100(2):126-31.

(12) Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res Q Exerc Sport 2000;71(2 Suppl):S1-14.

(13) Ainsworth BE, Haskell WL, Leon AS, Jacobs DR, Jr., Montoye HJ, Sallis JF, et al. Compendium of physical activities: classification of energy costs of human physical activities. Med Sci Sports Exerc 1993;25(1):71-80.

(14) Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Med Sci Sports Exerc 2000;32(9 Suppl):S498-S504.

(15) Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR, Tudor-Locke C, et al. 2011 Compendium of Physical Activities: A Second Update of Codes and MET Values. Med Sci Sports Exerc 2011;43(8):1575-81.

(16) Besson H, Brage S, Jakes RW, Ekelund U, Wareham NJ. Estimating physical activity energy expenditure, sedentary time, and physical activity intensity by self-report in adults. Am J Clin Nutr 2010;91(1):106-14.

(17) Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 2012;380(9838):219-29.

(18) Morris JN, Heady JA, Raffle PA, Roberts CG, Parks JW. Coronary heart-disease and physical activity of work. Lancet 1953;265(6795):1053-7.

(19) Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Med Sci Sports Exerc 2007;39(8):1423-34.

(20) Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. Jama 1995;273(5):402-7.

(21) Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc 2011;43(7):1334-59.

(22) Wen CP, Wai JP, Tsai MK, Yang YC, Cheng TY, Lee MC, et al. Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. Lancet 2011;378(9798):1244-53.

(23) Kohl HW, III. Physical activity and cardiovascular disease: evidence for a dose response. Med Sci Sports Exerc 2001;33(6 Suppl):S472-S483.

(24) Lee IM, Skerrett PJ. Physical activity and all-cause mortality: what is the dose-response relation? Med Sci Sports Exerc 2001;33(6 Suppl):S459-S471.

(25) Sattelmair J, Pertman J, Ding EL, Kohl HW, III, Haskell W, Lee IM. Dose response between physical activity and risk of coronary heart disease: a meta-analysis. Circulation 2011;124(7):789-95.

(26) De ti kostråd. Ernæringsrådet i Grønland . 17-12-2012. Available from: http://www.paarisa.gl/home/suliniutit/nerisat_aalanerlu/nerisassat.aspx

(27) Bjerregaard P. Rapid socio-cultural change and health in the Arctic. Int J Circumpolar Health 2001;60(2):102-11.

(28) Young TK, Bjerregaard P. Health transitions in Arctic populations. Toronto: University of Toronto Press; 2008;23-39.

(29) Bjerregaard P, Curtis T. Cultural change and mental health in Greenland: the association of childhood conditions, language, and urbanization with mental health and suicidal thoughts among the Inuit of Greenland. Soc Sci Med 2002;54(1):33-48.

(30) Gracey M, King M. Indigenous health part 1: determinants and disease patterns. Lancet 2009 4;374(9683):65-75.

(31) Omran AR. The epidemiologic transition: a theory of the epidemiology of population change. 1971. Milbank Q 2005;83(4):731-57.

(32) Yusuf S, Reddy S, Ounpuu S, Anand S. Global burden of cardiovascular diseases: part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. Circulation 2001;104(22):2746-53.

(33) Katzmarzyk PT, Mason C. The physical activity transition. J Phys Act Health 2009;6(3):269-80.

(34) Snodgrass JJ, Leonard WR, Tarskaia LA, Schoeller DA. Total energy expenditure in the Yakut (Sakha) of Siberia as measured by the doubly labeled water method. Am J Clin Nutr 2006;84(4):798-806.

(35) Pontzer H, Raichlen DA, Wood BM, Mabulla AZ, Racette SB, Marlowe FW. Hunter-gatherer energetics and human obesity. PLoS One 2012;7(7):e40503.

(36) Rode A, Shephard RJ. Ten years of "civilization": fitness of Canadian Inuit. J Appl Physiol 1984;56(6):1472-7.

(37) King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. Diabetes Care 1998;21(9):1414-31.

(38) Helmrich SP, Ragland DR, Leung RW, Paffenbarger RS, Jr. Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. N Engl J Med 1991;325(3):147-52.

(39) Helmrich SP, Ragland DR, Paffenbarger RS, Jr. Prevention of non-insulin-dependent diabetes mellitus with physical activity. Med Sci Sports Exerc 1994;26(7):824-30.

(40) Laaksonen DE, Lindstrom J, Lakka TA, Eriksson JG, Niskanen L, Wikstrom K, et al. Physical activity in the prevention of type 2 diabetes: the Finnish diabetes prevention study. Diabetes 2005;54(1):158-65.

(41) Lynch J, Helmrich SP, Lakka TA, Kaplan GA, Cohen RD, Salonen R, et al. Moderately intense physical activities and high levels of cardiorespiratory fitness reduce the risk of non-insulin-dependent diabetes mellitus in middle-aged men. Arch Intern Med 1996;156(12):1307-14.

(42) Manson JE, Nathan DM, Krolewski AS, Stampfer MJ, Willett WC, Hennekens CH. A prospective study of exercise and incidence of diabetes among US male physicians. Jama 1992;268(1):63-7.

(43) Tuomilehto J, Lindstrom J, Eriksson JG, Valle TT, Hamalainen H, Ilanne-Parikka P, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. N Engl J Med 2001;344(18):1343-50.

(44) Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346(6):393-403.

(45) Kriska AM, Edelstein SL, Hamman RF, Otto A, Bray GA, Mayer-Davis EJ, et al. Physical activity in individuals at risk for diabetes: Diabetes Prevention Program. Med Sci Sports Exerc 2006;38(5):826-32.

(46) Lindstrom J, Louheranta A, Mannelin M, Rastas M, Salminen V, Eriksson J, et al. The Finnish Diabetes Prevention Study (DPS): Lifestyle intervention and 3-year results on diet and physical activity. Diabetes Care 2003;26(12):3230-6.

(47) Pi-Sunyer X, Blackburn G, Brancati FL, Bray GA, Bright R, Clark JM, et al. Reduction in weight and cardiovascular disease risk factors in individuals with type 2 diabetes: one-year results of the look AHEAD trial. Diabetes Care 2007;30(6):1374-83.

(48) Kriska AM, Hanley AJ, Harris SB, Zinman B. Physical activity, physical fitness, and insulin and glucose concentrations in an isolated Native Canadian population experiencing rapid lifestyle change. Diabetes Care 2001;24(10):1787-92.

(49) Adler AI, Boyko EJ, Schraer CD, Murphy NJ. The negative association between traditional physical activities and the prevalence of glucose intolerance in Alaska Natives. Diabet Med 1996;13(6):555-60.

(50) Jørgensen ME, Moustgaard H, Bjerregaard P, Borch-Johnsen K. Gender differences in the association between westernization and metabolic risk among Greenland Inuit. Eur J Epidemiol 2006;21(10):741-8.

(51) Assah FK, Ekelund U, Brage S, Mbanya JC, Wareham NJ. Free-Living Physical Activity Energy Expenditure Is Strongly Related to Glucose Intolerance in Cameroonian Adults Independently of Obesity. Diabetes Care 2009;32(2):367-9.

(52) Assah FK, Ekelund U, Brage S, Mbanya JC, Wareham NJ. Urbanization, physical activity, and metabolic health in sub-Saharan Africa. Diabetes Care 2011;34(2):491-6.

(53) Healy GN, Wijndaele K, Dunstan DW, Shaw JE, Salmon J, Zimmet PZ, et al. Objectively measured sedentary time, physical activity, and metabolic risk: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). Diabetes Care 2008;31(2):369-71.

(54) Balkau B, Mhamdi L, Oppert JM, Nolan J, Golay A, Porcellati F, et al. Physical activity and insulin sensitivity: the RISC study. Diabetes 2008;57(10):2613-8.

(55) Ekelund U, Franks PW, Sharp S, Brage S, Wareham NJ. Increase in physical activity energy expenditure is associated with reduced metabolic risk independent of change in fatness and fitness. Diabetes Care 2007;30(8):2101-6.

(56) Assah FK, Brage S, Ekelund U, Wareham NJ. The association of intensity and overall level of physical activity energy expenditure with a marker of insulin resistance. Diabetologia 2008;51(8):1399-407.

(57) Guthold R, Ono T, Strong KL, Chatterji S, Morabia A. Worldwide variability in physical inactivity a 51-country survey. Am J Prev Med 2008;34(6):486-94.

(58) Mbalilaki JA, Masesa Z, Stromme SB, Hostmark AT, Sundquist J, Wandell P, et al. Daily energy expenditure and cardiovascular risk in Masai, rural and urban Bantu Tanzanians. Br J Sports Med 2010;44:121-126.

(59) Monda KL, Gordon-Larsen P, Stevens J, Popkin BM. China's transition: the effect of rapid urbanization on adult occupational physical activity. Soc Sci Med 2007;64(4):858-70.

(60) Sobngwi E, Mbanya JC, Unwin NC, Kengne AP, Fezeu L, Minkoulou EM, et al. Physical activity and its relationship with obesity, hypertension and diabetes in urban and rural Cameroon. Int J Obes Relat Metab Disord 2002;26(7):1009-16.

(61) Yamauchi T, Umezaki M, Ohtsuka R. Influence of urbanisation on physical activity and dietary changes in Huli-speaking population: a comparative study of village dwellers and migrants in urban settlements. Br J Nutr 2001;85(1):65-73.

(62) Christensen DL, Friis H, Mwaniki DL, Kilonzo B, Tetens I, Boit MK, et al. Prevalence of glucose intolerance and associated risk factors in rural and urban populations of different ethnic groups in Kenya. Diabetes Res Clin Pract 2009;84(3):303-310.

(63) Levine JA, McCrady SK, Boyne S, Smith J, Cargill K, Forrester T. Non-exercise physical activity in agricultural and urban people. Urban Stud 2011;48(11):2417-27.

(64) Ebrahim S, Kinra S, Bowen L, Andersen E, Ben-Shlomo Y, Lyngdoh T, et al. The effect of rural-to-urban migration on obesity and diabetes in India: a cross-sectional study. PLoS Med 2010;7(4):e1000268.

(65) Mohan V, Deepa M, Anjana RM, Lanthorn H, Deepa R. Incidence of diabetes and pre-diabetes in a selected urban south Indian population (CUPS-19). J Assoc Physicians India 2008;56:152-7.

(66) Jorgensen ME, Borch-Johnsen K, Witte DR, Bjerregaard P. Diabetes in Greenland and its relationship with urbanization. Diabet Med 2012;29(6):755-60.

(67) Sobngwi E, Mbanya JC, Unwin NC, Porcher R, Kengne AP, Fezeu L, et al. Exposure over the life course to an urban environment and its relation with obesity, diabetes, and hypertension in rural and urban Cameroon. Int J Epidemiol 2004;33(4):769-76.

(68) Allender S, Foster C, Hutchinson L, Arambepola C. Quantification of urbanization in relation to chronic diseases in developing countries: a systematic review. J Urban Health 2008;85(6):938-51.

(69) Bjerregaard P, Dahl-Petersen IK. How well does social variation mirror secular change in prevalence of cardiovascular risk factors in a country in transition? Am J Hum Biol 2011;23(6):774-9.

(70) van Poppel MNM, Chinapaw MJM, Mokkink LB, van Mechelen W, Terwee CB. Physical Activity Questionnaires for Adults A Systematic Review of Measurement Properties. Sports Medicine 2010;40(7):565-600.

(71) Helmerhorst HJ, Brage S, Warren J, Besson H, Ekelund U. A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. Int J Behav Nutr Phys Act 2012;9:103.

(72) Bauman A, Bull F, Chey T, Craig CL, Ainsworth BE, Sallis JF, et al. The International Prevalence Study on Physical Activity: results from 20 countries. Int J Behav Nutr Phys Act 2009;6(1):21.

(73) IPAQ-group. IPAQ. IPAQ-group 2007. Available from: URL: www.ipaq.ki.se

(74) Hallal PC, Simoes E, Reichert FF, Azevedo MR, Ramos LR, Pratt M, et al. Validity and Reliability of the Telephone-Administered International Physical Activity Questionnaire in Brazil. Journal of Physical Activity & Health 2010;7(3):402-9.

(75) Lachat CK, Verstraeten R, Khanh lN, Hagstromer M, Khan NC, Van Ndo A, et al. Validity of two physical activity questionnaires (IPAQ and PAQA) for Vietnamese adolescents in rural and urban areas. Int J Behav Nutr Phys Act 2008;5:37.

(76) Macfarlane D, Chan A, Cerin E. Examining the validity and reliability of the Chinese version of the International Physical Activity Questionnaire, long form (IPAQ-LC). Public Health Nutr 2010 13;1-8.

(77) Nang EEK, Ngunjiri SAG, Wu Y, Salim A, Tai ES, Lee J, et al. Validity of the international physical activity questionnaire and the Singapore prospective study program physical activity questionnaire in a multiethnic urban Asian population. Bmc Medical Research Methodology 2011 13;11.

(78) Craig CL, Marshall AL, Sjostrom M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35(8):1381-95.

(79) Westerterp KR, Plasqui G. Physical activity and human energy expenditure. Curr Opin Clin Nutr Metab Care 2004;7(6):607-13.

(80) Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc 2008;40(1):181-8.

(81) John D, Freedson P. ActiGraph and Actical physical activity monitors: a peek under the hood. Med Sci Sports Exerc 2012;44(1 Suppl 1):S86-S89.

(82) Freedson PS, Lyden K, Kozey-Keadle S, Staudenmayer J. Evaluation of artificial neural network algorithms for predicting METs and activity type from accelerometer data: validation on an independent sample. J Appl Physiol 2011;111(6):1804-12.

(83) Corder K, Brage S, Ekelund U. Accelerometers and pedometers: methodology and clinical application. Curr Opin Clin Nutr Metab Care 2007;10(5):597-603.

(84) Ceesay SM, Prentice AM, Day KC, Murgatroyd PR, Goldberg GR, Scott W, et al. The use of heart rate monitoring in the estimation of energy expenditure: a validation study using indirect whole-body calorimetry. Br J Nutr 1989;61(2):175-86.

(85) Livingstone MB. Heart-rate monitoring: the answer for assessing energy expenditure and physical activity in population studies? Br J Nutr 1997;78(6):869-71.

(86) Assah FK, Ekelund U, Brage S, Wright A, Mbanya JC, Wareham NJ. Accuracy and validity of a combined heart rate and motion sensor for the measurement of free-living physical activity energy expenditure in adults in Cameroon. Int J Epidemiol 2011;40(1):112-20.

(87) Brage S, Brage N, Franks P, Ekelund U, Wareham N. Reliability and validity of the ActiHeart®: A single-piece instrument that measures acceleration, heart rate, and heart rate variability. 2003.

(88) Crouter SE, Churilla JR, Bassett DRJ. Accuracy of the Actiheart for the assessment of energy expenditure in adults. Eur J Clin Nutr 2008;62(6):704-11.

(89) IPAQ-group. IPAQ analyse guidelines . IPAQ-group 2011. Available from: URL: http://www.ipaq.ki.se/scoring.pdf

(90) Brage S, Ekelund U, Brage N, Hennings MA, Froberg K, Franks PW, et al. Hierarchy of individual calibration levels for heart rate and accelerometry to measure physical activity. J Appl Physiol 2007;103(2):682-92.

(91) Brage S, Brage N, Franks PW, Ekelund U, Wong MY, Andersen LB, et al. Branched equation modeling of simultaneous accelerometry and heart rate monitoring improves estimate of directly measured physical activity energy expenditure. J Appl Physiol 2004;96(1):343-51.

(92) Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. Lancet 1986;1(8476):307-10.

(93) Henry CJK. Basal metabolic rate studies in humans: measurement and development of new equations. Public Health Nutrition 2005;8(7A):1133-52.

(94) Boon RM, Hamlin MJ, Steel GD, Ross JJ. Validation of the New Zealand Physical Activity Questionnaire (NZPAQ-LF) and the International Physical Activity Questionnaire (IPAQ-LF) with Accelerometry. Br J Sports Med 2010;44(10):741-6.

(95) Hagstromer M, Oja P, Sjostrom M. The International Physical Activity Questionnaire (IPAQ): a study of concurrent and construct validity. Public Health Nutr 2006;9(6):755-62.

(96) Sebastiao E, Gobbi S, Chodzko-Zajko W, Schwingel A, Papini CB, Nakamura PM, et al. The International Physical Activity Questionnaire-long form overestimates self-reported physical activity of Brazilian adults. Public Health 2012;126(11):967-75.

(97) Hagstromer M, Ainsworth BE, Oja P, Sjostrom M. Comparison of a subjective and an objective measure of physical activity in a population sample. J Phys Act Health 2010;7(4):541-50.

(98) Ekelund U, Sepp H, Brage S, Becker W, Jakes R, Hennings M, et al. Criterion-related validity of the last 7-day, short form of the International Physical Activity Questionnaire in Swedish adults. Public Health Nutr 2006;9(2):258-65.

(99) Klesges RC, Eck LH, Mellon MW, Fulliton W, Somes GW, Hanson CL. The accuracy of self-reports of physical activity. Med Sci Sports Exerc 1990;22(5):690-7.

(100) Altschuler A, Picchi T, Nelson M, Rogers JD, Hart J, Sternfeld B. Physical activity questionnaire comprehension: lessons from cognitive interviews. Med Sci Sports Exerc 2009;41(2):336-43.

(101) Ekelund U, Brage S, Griffin SJ, Wareham NJ. Objectively measured moderate- and vigorous-intensity physical activity but not sedentary time predicts insulin resistance in high-risk individuals. Diabetes Care 2009;32(6):1081-6.

(102) Healy GN, Dunstan DW, Salmon J, Cerin E, Shaw JE, Zimmet PZ, et al. Objectively measured light-intensity physical activity is independently associated with 2-h plasma glucose. Diabetes Care 2007;30(6):1384-9.

(103) Dunstan DW, Salmon J, Owen N, Armstrong T, Zimmet PZ, Welborn TA, et al. Associations of TV viewing and physical activity with the metabolic syndrome in Australian adults. Diabetologia 2005;48(11):2254-61.

(104) Hamilton MT, Healy GN, Dunstan DW, Zderic TW, Owen N. Too Little Exercise and Too Much Sitting: Inactivity Physiology and the Need for New Recommendations on Sedentary Behavior. Curr Cardiovasc Risk Rep 2008;2(4):292-8.

(105) Owen N, Bauman A, Brown W. Too much sitting: a novel and important predictor of chronic disease risk? Br J Sports Med 2009;43(2):81-3.

(106) Wareham NJ, Wong MY, Day NE. Glucose intolerance and physical inactivity: the relative importance of low habitual energy expenditure and cardiorespiratory fitness. Am J Epidemiol 2000;152(2):132-9.

(107) Shephard RJ, Aoyagi Y. Measurement of human energy expenditure, with particular reference to field studies: an historical perspective. Eur J Appl Physiol 2012;112(8):2785-815.

(108) Eriksen L, Dahl-Petersen I, Haugaard SB, Dela F. Comparison of the effect of multiple short-duration with single long-duration exercise sessions on glucose homeostasis in type 2 diabetes mellitus. Diabetologia 2007;50(11):2245-53.

(109) Murphy MH, Blair SN, Murtagh EM. Accumulated versus Continuous Exercise for Health Benefit A Review of Empirical Studies. Sports Medicine 2009;39(1):29-43.

(110) Rode A, Shephard RJ. Fitness of the Canadian Eskimo--the influence of season. Med Sci Sports 1973;5(3):170-3.

(111) Dahly DL, Adair LS. Quantifying the urban environment: a scale measure of urbanicity outperforms the urban-rural dichotomy. Soc Sci Med 2007;64(7):1407-19.

(112) McDade TW, Adair LS. Defining the "urban" in urbanization and health: a factor analysis approach. Soc Sci Med 2001;53(1):55-70.

(113) Stamatakis E, Ekelund U, Wareham NJ. Temporal trends in physical activity in England: the Health Survey for England 1991 to 2004. Prev Med 2007;45(6):416-23.

(114) Petersen CB, Thygesen LC, Helge JW, Gronbaek M, Tolstrup JS. Time trends in physical activity in leisure time in the Danish population from 1987 to 2005. Scand J Public Health 2010;38(2):121-8.

(115) Vorster HH, Venter CS, Wissing MP, Margetts BM. The nutrition and health transition in the North West Province of South Africa: a review of the THUSA (Transition and Health during Urbanisation of South Africans) study. Public Health Nutr 2005;8(5):480-90.

(116) Mendez MA, Monteiro CA, Popkin BM. Overweight exceeds underweight among women in most developing countries. Am J Clin Nutr 2005;81(3):714-21.

(117) Kriska AM, Pereira MA, Hanson RL, de Court, Zimmet PZ, Alberti KG, et al. Association of physical activity and serum insulin concentrations in two populations at high risk for type 2 diabetes but differing by BMI. Diabetes Care 2001;24(7):1175-80.

(118) Kriska AM, LaPorte RE, Pettitt DJ, Charles MA, Nelson RG, Kuller LH, et al. The association of physical activity with obesity, fat distribution and glucose intolerance in Pima Indians. Diabetologia 1993;36(9):863-9.

(119) Pereira MA, Kriska AM, Joswiak ML, Dowse GK, Collins VR, Zimmet PZ, et al. Physical inactivity and glucose intolerance in the multiethnic island of Mauritius. Med Sci Sports Exerc 1995;27(12):1626-34.

(120) Faerch K, Borch-Johnsen K, Holst JJ, Vaag A. Pathophysiology and aetiology of impaired fasting glycaemia and impaired glucose tolerance: does it matter for prevention and treatment of type 2 diabetes? Diabetologia 2009;52(9):1714-23.

(121) Rana JS, Li TY, Manson JE, Hu FB. Adiposity compared with physical inactivity and risk of type 2 diabetes in women. Diabetes Care 2007;30(1):53-8.

(122) Hu G, Lindstrom J, Valle TT, Eriksson JG, Jousilahti P, Silventoinen K, et al. Physical activity, body mass index, and risk of type 2 diabetes in patients with normal or impaired glucose regulation. Arch Intern Med 2004;164(8):892-6.

(123) Weinstein AR, Sesso HD, Lee IM, Cook NR, Manson JE, Buring JE, et al. Relationship of physical activity vs body mass index with type 2 diabetes in women. Jama 2004;292(10):1188-94.

(124) Morton LM, Cahill J, Hartge P. Reporting participation in epidemiologic studies: a survey of practice. Am J Epidemiol 2006;163(3):197-203.

(125) Brage S, Brage N, Franks PW, Ekelund U, Wareham NJ. Reliability and validity of the combined heart rate and movement sensor Actiheart. Eur J Clin Nutr 2005;59(4):561-70.

(126) Rennie KL, Wareham NJ. The validation of physical activity instruments for measuring energy expenditure: problems and pitfalls. Public Health Nutr 1998;1(4):265-71.

(127) Bauman A, Ainsworth BE, Sallis JF, Hagstromer M, Craig CL, Bull FC, et al. The Descriptive Epidemiology of Sitting A 20-Country Comparison Using the International Physical Activity Questionnaire (IPAQ). American Journal of Preventive Medicine 2011;41(2):228-35.

(128) Healy GN, Dunstan DW, Salmon J, Cerin E, Shaw JE, Zimmet PZ, et al. Breaks in sedentary time: beneficial associations with metabolic risk. Diabetes Care 2008;31(4):661-6.

(129) Holtermann A, Hansen JV, Burr H, Sogaard K, Sjogaard G. The health paradox of occupational and leisure-time physical activity. Br J Sports Med 2012;46(4):291-5.

(130) Heath GW, Gavin JR, III, Hinderliter JM, Hagberg JM, Bloomfield SA, Holloszy JO. Effects of exercise and lack of exercise on glucose tolerance and insulin sensitivity. J Appl Physiol 1983;55(2):512-7.

(131) Koivisto VA, Yki-Jarvinen H, DeFronzo RA. Physical training and insulin sensitivity. Diabetes Metab Rev 1986;1(4):445-81.

(132) Kriska A. Can a physically active lifestyle prevent type 2 diabetes? Exerc Sport Sci Rev 2003;31(3):132-7.

(133) Intille SS, Lester J, Sallis JF, Duncan G. New horizons in sensor development. Med Sci Sports Exerc 2012;44(1 Suppl 1):S24-S31.

(134) Coble JD, Rhodes RE. Physical Activity and Native Americans: A Review. American Journal of Preventive Medicine 2006;31(1):36-46.

(135) Sallis JF, Bauman A, Pratt M. Environmental and policy interventions to promote physical activity. Am J Prev Med 1998;15(4):379-97.

(136) Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. Annu Rev Public Health 2006;27:297-322.

(137) Strath SJ, Swartz AM, Bassett DR, Jr., O'Brien WL, King GA, Ainsworth BE. Evaluation of heart rate as a method for assessing moderate intensity physical activity. Med Sci Sports Exerc 2000;32(9 Suppl):S465-S470.

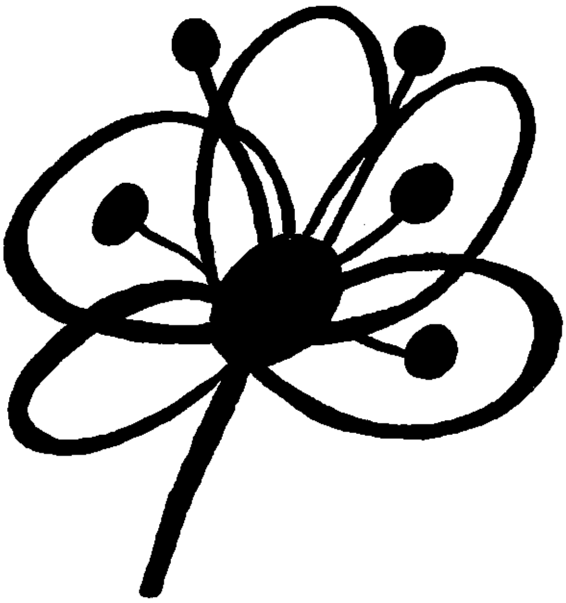
(138) Strath SJ, Brage S, Ekelund U. Integration of physiological and accelerometer data to improve physical activity assessment. Med Sci Sports Exerc 2005;37(11 Suppl):S563-S571.

(139) Stegle O, Fallert SV, Mackay DJC, Brage S. Gaussian process robust regression for noisy heart rate data. Ieee Transactions on Biomedical Engineering 2008;55(9):2143-51.

Appendix I – danish questionnaire

Lbnr: ____________________

MÞrkat fra blodprßve-
seddel klÞbes ind her



Interviewer ___________________________

Dato: _________________

Start p¬ interview ___________

Slut p¬ interview ___________

De næste spørgsmål drejer sig om hvor lang tid du har været fysisk aktiv de sidste 7 dage. Den første del handler om dit arbejde, herunder jagt og fiskeri som erhverv, men ikke husarbejde

57. Har du for øjeblikket arbejde uden for hjemmet?

ja .... ☐ 1
nej .... ☐ 2 → g¬ til spm. 64

58. I løbet af de sidste 7 dage, hvor mange dage har du udført hård fysisk aktivitet på dit arbejde? Tænk kun på aktiviteter som du udfører mindst 10 minutter ad gangen? *(Hård fysisk aktivitet er aktivitet, som er meget fysisk anstrengende, og hvor du øger din vejrtrækning meget; f.eks. tunge løft, gravearbejde, tungt byggearbejde, trappegang)*

_____ dage om ugen
har ikke h¬rdt fysisk arbejde .... ☐ 0 → g¬ til spm. 60

59. Hvor lang tid brugte du i gennemsnit om dagen på hård fysisk aktivitet?

_____ timer om dagen

_____ minutter om dagen

60. I løbet af de sidste 7 dage, hvor mange dage har du udført moderat fysisk aktivitet som på dit arbejde? *(Moderat aktivitet er mindre anstrengende og øger vejrtrækningen i nogen grad; f.eks. mindre løft)*

_____ dage om ugen
har ikke moderat fysisk arbejde .... ☐ 0 → g¬ til spm. 62

61. Hvor lang tid brugte du i gennemsnit om dagen på moderat fysisk aktivitet?

_____ timer om dagen

_____ minutter om dagen

62. **I løbet af de sidste 7 dage, hvor mange dage har du gået mindst 10 min. ad gangen på dit arbejde? Medregn ikke gang til og fra arbejde**

_____ dage om ugen
har ikke g¬ende arbejde .... ☐ 0 → g¬ til spm. 64

63. **Hvor lang tid brugte du i gennemsnit om dagen på at gå på dit arbejde?**

_____ timer om dagen

_____ minutter om dagen

De næste spørgsmål handler om transport fra sted til sted

64. **I løbet af de sidste 7 dage, hvor mange dage har du kørt i bil, bus eller snescooter?**

_____ dage om ugen
har ikke kßrt med bil, bus eller snescooter .... ☐ 0 → g¬ til spm. 66

65. **Hvor lang tid brugte du i gennemsnit om dagen på at transportere dig med bil, bus eller snescooter?**

_____ timer om dagen

_____ minutter om dagen

66. **I løbet af de sidste 7 dage, hvor mange dage har du cyklet mindst 10 min. ad gangen for at komme fra sted til sted?**

_____ dage om ugen
har ikke cyklet .... ☐ 0 → g¬ til spm. 68

67. **Hvor lang tid brugte du i gennemsnit om dagen på at cykle fra sted til sted?**

_____ timer om dagen

_____ minutter om dagen

68. **I løbet af de sidste 7 dage, hvor mange dage har du gået mindst 10 min. ad gangen fra sted til sted?**

_____ dage om ugen

har ikke g¬et fra sted til sted .... ☐ 0 → g¬ til spm. 70

69. **Hvor lang tid brugte du i gennemsnit om dagen på at gå fra sted til sted?**

_____ timer om dagen

_____ minutter om dagen

De næste spørgsmål handler om arbejde i og omkring hjemmet f.eks. husarbejde, reparationer, vedligeholdelse og pasning af børn og familie. Tænk kun på fysisk aktivitet som du udfører mindst 10 minutter ad gangen

70. **I løbet af de sidste 7 dage, hvor mange dage har du udført hård fysisk aktivitet i hjemmet?** *(f.eks. tunge løft, skovle sne, gravearbejde, hente vand)*

_____ dage om ugen

har ikke udfßrt tungt fysisk arbejde i hjemmet .... ☐ 0 → g¬ til spm. 72

71. **Hvor lang tid brugte du i gennemsnit om dagen på at udføre hårdt fysisk arbejde i hjemmet?**

_____ timer om dagen

_____ minutter om dagen

72. **Hvor mange dage har du udført moderat fysisk aktivitet i hjemmet?** *(f.eks. reparationer i hjemmet, reparation af udstyr, rengøring og tøjvask, pleje af børn eller gamle)*

_____ dage om ugen

har ikke udfßrt moderat fysisk aktivitet .... ☐ 0 → g¬ til spm. 74

73. **Hvor lang tid brugte du i gennemsnit om dagen på moderat aktivitet i hjemmet?**

_____ timer om dagen

_____ minutter om dagen

De næste spørgsmål handler om motion, sport og anden fysisk aktivitet i fritiden. Medregn ikke aktiviteter, som du allerede har beskrevet i de foregående afsnit

74. **I løbet af de sidste 7 dage, hvor mange dage har du gået mindst 10 min. ad gangen i fritiden?**

_____ dage om ugen

har ikke g¬et i fritiden .... ☐ 0 → g¬ til spm. 76

75. **Hvor lang tid brugte du i gennemsnit om dagen på at gå i fritiden?**

_____ timer om dagen

_____ minutter om dagen

76. **I løbet af de sidste 7 dage, hvor mange dage har du udført hård fysisk aktivitet i fritiden?** *(f.eks. aerobics, løb, kampsport, fodbold, skiløb)*

_____ dage om ugen

ingen h¬rd fysisk aktivitet i fritiden .... ☐ 0 → g¬ til spm. 78

77. Hvor lang tid brugte du i gennemsnit om dagen på hård fysisk aktivitet i fritiden?

_____ timer om dagen

_____ minutter om dagen

78. Hvor mange dage har du udført moderat fysisk aktivitet i fritiden? *(f.eks. cykling i lavt tempo, svømning i lavt tempo, vandreture)*

_____ dage om ugen

ingen moderat aktivitet i fritiden .... ☐ 0 → g¬ til spm. 80

79. Hvor lang tid brugte du i gennemsnit om dagen på moderat fysisk aktivitet i fritiden?

_____ timer om dagen

_____ minutter om dagen

De sidste spørgsmål handler om den tid, du sidder stille på arbejdet og i fritiden *(f.eks. sidde ved et skrivebord, besøge venner, læse, computer og TV) Medregn ikke bilkørsel o.l.*

80. I løbet af de sidste 7 dage, hvor meget tid har du brugt på stillesiddende aktiviteter på hverdage?

_____ timer om dagen

_____ minutter om dagen

81. I løbet af de sidste 7 dage, hvor meget tid har du brugt på stillesiddende aktiviteter om dagen i weekenden?

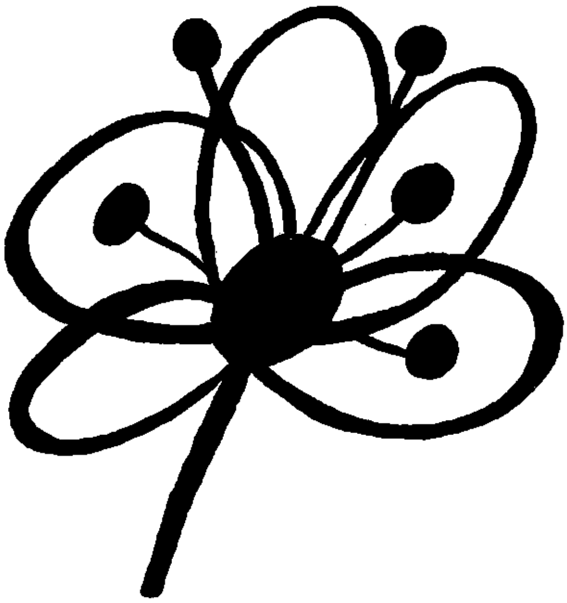
_____ timer om dagen

_____ minutter om dagen

Appendix II – greenlandic questionnaire

Lbnr: ____________________

MÞrkat fra blodprßve-
seddel klÞbes ind her



Interviewer ____________________________

Dato: __________________

Start p¬ interview ___________

Slut p¬ interview ___________

Apeqqutit tulliit ulluni kingullerni piffissami qanoq sivisutigisumik timinnik atuisimanernut tunngassuteqarput. Immikkoortoq siulleq sulinernut tunngassuteqarpoq, tassani inuussutissarsiutigalugu aallaaniarneq aalisarnelu ilanngullugit, angerlarsimaffimmili suliat ilanngunnagit

57. Massakkut angerlarsimaffiup avataani suliffeqarpit?

aap .... ☐ 1
naamik .... ☐ 2 → apeqq. 64 nuugit

58. Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit suliffinni oqimaatsunik suliaqartarpit? Suliat 10 minuttinit sivisunerusumik suliarineqartut kisiisa eqqarsaatigikkit? *(Suliat oqimaatsut annertuumik nukissorfiusut, anerterinerulernernillu kinguneqartut; soorlu oqimaatsunik kivitsinerit, assaanerit, sanaartornermi oqimaatsunik suliaqarneq, tummeqqatigoornerit)*

sapaatip akunneranut ullut _____
oqimaatsunik suliaqanngilanga .... ☐ 0 → apeqq. 60 nuugit

59. Ulluni taakkunani piffissaq qanoq sivisutigisoq agguaqatigiissillugu oqimaatsunik suliaqarlutit atorsimaviuk?

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

60. Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit oqimaakannersunik suliffinni suliaqartarsimavit? *(Oqimaakannersunik sulineq ilungersunannginnerusuuvoq, anerterinerunermillu annikinnerusumik kinguneqartarluni; soorlu kivitsinerit annikinnerusut)*

sapaatip akunneranut ullut _____
oqimaakannersunik suliaqartanngilanga .... ☐ 0 → apeqq. 62 nuugit

61. **Ulluni taakkunani suliffinni agguaqatigiissillugu qanoq sivisutigisumik oqimaakannersunik suliaqartarpit?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

62. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit sulinerni minnerpaamik minuttini 10-ni pisuttarpit? Suliartornermi soraarnermilu pisuttarnerit ilanngunneqassanngillat**

sapaatip akunneranut ullut _____
sulininni pisuttariaqartanngilanga .... ☐ 0 → apeqq. 64 nuugit

63. **Ulluni taakkunani sulinernut atatillugu agguaqatigiissillugu qanoq sivisutigisumik pisuttarpit?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

Apeqqutit tulliuttut piffimmit piffimmut angallanermut tunngapput

64. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit biilit busit snescooterilluunniit atorlugit ingerlasimavit?**

sapaatip akunneranut ullut _____
biilit, busit snescooterilluunnit atorlugit ingerlanngilanga .... ☐ 0 → apeqq. 66 nuugit

65. **Ulluni taakkunani qanoq agguaqatigiissillugu sivisutigisumik biilit, busit snescooterilluunniit atorlugit angallanneqartarpit?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

66. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit piffimmit piffimmut ingerlanernut atatillugu minnerpaamik minuttsini 10-ni sivisussusilimmi cykelertarpit?**

sapaatip akunneranut ullut _____
cykelinngilanga .... ☐ 0 → apeqq. 68 nuugit

67. **Ulluni taakkunani piffimmit piffimmut cykilernerni agguaqatigiissillugu piffissaq qanoq sivisutigisoq atortarpiuk?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

68. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit piffimmit piffimmut minnerpaamik minuttini 10-ni pisuttarsimavit?**

sapaatip akunneranut ullut _____
piffimmit piffimmut pisuttariaqartarsimanngilanga .... ☐ 0 → apeqq. 70 nuugit

69. **Ulluni taakkunani piffimmit piffimmut pisunnerni agguaqatigiissillugu piffissaq qanoq sivisutigisoq atortarpiuk?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

Apeqqutit tulliuttut angerlarsimaffimmi eqqaanilu soorlu angerlarsimaffimmut tunngasunik suliaqarnernut, iluarsaassinernut, aserfallatsaaliuinernut meeqqanillu ilaquttanillu paarsinernut tunngassuteqarput. Suliat 10 minuttinit sivisunerusumik suliarineqartut kisiisa eqqarsaatigikkit

70. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit angerlarsimaffinni oqimaatsunik suliaqartarpit?** *(soorlu oqimaatsunik kivitsinerit, apummik nivannerit, assaanerit, imertartornerit)*

sapaatip akunneranut ullut _____
angerlarsimaffimmi oqimaatsunik suliaqanngilanga .... ☐ 0 → apeqq. 72 nuugit

71. **Ulluni taakkunani angerlarsimaffimmi agguaqatigiissillugu piffissaq qanoq sivisutigisoq oqimaatsunik suliaqarlutit atortarpiuk?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

72. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit angerlarsimaffinni oqimaakannersunik suliaqartarsimavit?** *(soorlu angerlarsimaffimmi iluarsaassinernut, atortunik iluarsaassinerni, eqqiaanerni atisanik errorsinerni, meeqqanik utoqqarnillu paaqqutarinninermi)*

sapaatip akunneranut ullut _____
oqimaakannersunik suliaqartanngilanga .... ☐ 0 → apeqq. 74 nuugit

73. **Ulluni taakkunani angerlarsimaffinni oqimaakernersunik suliaqarlutit agguaqatigiissillugu piffissaq qanoq sivisutigisoq atortarpiuk?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

Apeqqutit tulliuttut sunngiffimmi timigissarnermut, timersornermut timiluunniit atorlugu sammisaqarnermut tunngassuteqarput. Immikkoortuni siuliini suliat ilannguteriikkatit matumani ilanngutissanngilatit

74. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit sunngiffinni minnerpaamik minuttini 10-ni pisuttarsimavit?**

sapaatip akunneranut ullut _____
sunngiffinni pisuttanngilanga .... ☐ 0 → apeqq. 76 nuugit

75. **Ulluni taakkunani sunngiffinni agguaqatigiissillugu piffissaq qanoq sivisutigisoq pisuttarsimavit?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

76. **Ullut kinguliit arfineq marluk ingerlaneranni ullut qassit sunngiffinni oqimaatsunik sammisaqartarsimavit?** *(soorlu aerobics,arpanneq, imminut illersorluni timersuutinik sammisaqarneq, arsarneq, sisorarneq)*

sapaatip akunneranut ullut _____
sunngiffinni oqimaatsunik suliaqartanngilanga .... ☐ 0 → apeqq. 78 nuugit

77. **Ulluni taakkunani sunngiffinni oqimaatsunik sammisaqarlutit agguaqatigiissillugu piffissaq qanoq sivisutigisoq atortarpiuk?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

78. **Ulluni qanoq amerlatigisuni sunngiffinni oqimaakannersunik sammisaqartarsimvit?** *(soorlu sukkavallaanngitsumik cykilerneq, kingaatsumik nalunneq, pisuttuarneq)*

sapaatip akunneranut ullut _____

sunngiffinni oqimaakannersunik suliaqartanngilanga .... ☐ 0 → apeqq. 80 nuugit

79. **Ulluni taakkunani sunngiffinni oqimaakannersunik sammisaqarlutit agguaqatigiissillugu piffissaq qanoq sivisutigisoq atortarpiuk?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

Apeqqutit tulliuttut sulinerni sunngiffinnilu issiasarnernut piffissamut atortakkannut tunngassuteqarput *(Soorlu allaffimmi issianerit, ikinngutinut pulaarnerit, atuarneq, qarasaasiarsoqneq TV-lu).*
Biilernerit assigisaallu ilanngunneqassanngillat

80. **Ullut kinguliit arfineq marluk ingerlaneranni piffissaq qanoq sivisutigsoq ingillutit ulluinnarni suliaqartarsimavit?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

81. **Ulluni arfineq marlunni kingullerni sapaatit akunnerisa naanerini ullormut piffissami qanoq sivisutigisumi ingillutit suliaqartarsimavit?**

ullormut nalunaaquttap akunneri _____

ullormut minuttit _____

Appendix III – Overview of Accelerometry and heart rate monitoring

For a description of procedures in the data collection is referred to paper I.
A limited number of monitors was available for the study and therefore randomly assigned to a subgroup of participants at each study location. No monitors were given to participants in villages in Avanersuaq because of the limited time available at the study location (1-2 days). Moreover, we did not include recordings from the pilot study because the participants were not randomly assigned and were not included in the master sample.
Data from the monitors were manually trimmed to indicate the end of each participant's recording. The value of the first night of sleeping heart rate (SHR) was excluded. Based on the lowest HR, a 10% deviation was accepted as variation in SHR for the following nights. A mean SHR was calculated for every participant. The quality of the recordings based on the interpretation by the researcher was divided into 5 levels and reported on a log sheet. The ID number, sex, age, height and weight were validated with the master database and revised manually in the database. Moreover, it was noted if the participant suffered from heart disease or received medication that could influence the heart rate (beta-blockers). It was noted if the monitor was not given to a participant. An example could be that the participant was leaving the town for several days. On the log sheet it was noted if the calibration factor of the monitor was outside of the prescribed ranges. Data were cleaned according to written guidelines and with support from the MRC Epidemiology Unit in Cambridge, UK. A revised log sheet was provided by MRC including further changes to data, i.e. change of accelerometer calibration factors, which can get corrupted, but can be recovered by cross-referencing to other records obtained with the same monitor.
Step test data were available from 166 participants from two towns (Aasiiaat and Qasianguit). To keep the duration of the health examination reasonable for the participant (maximum 2.5 hours) it was decided to skip the test in the following health examinations. The step test data were used to calculate a group calibration model specific for this population. Individual calibration means available information on heart rate response to a known workload at the individual level. HR can be influenced by several factors, such as age, sex, training state, stroke volume and mental stress among others (137;138). It has been shown that some of these limitations can be overcome by individual calibration. However, in a paper by Brage et al it was suggested, that a group calibration model was reasonable to use at population level, although it would have a larger random error (90). The limitations of Accelerometry are mainly biomechanical, i.e. the accelerometry-PAI relation is different for different activities.
Heart rate data were pre-processed using robust Gaussian Process Regression for inference of latent heart rate trace, as described elsewhere (139). The combination of prolonged time periods of large heart rate uncertainty accompanied by no acceleration was used to classify all measured time points as wear or non-wear.
Caloric intensity of PA was estimated by combining the acceleration-based estimate of intensity (90) with the heart rate-based estimate from the population-specific equation (see above) in a branched equation

modelling framework (90;91). If available, step-calibrated HR was used instead of the group-calibrated HR estimate. Briefly, the branched equation modelling method predominantly uses the accelerometer estimate during low levels of heart rate and movement estimate and the heart rate estimate when both heart rate and acceleration levels are high, with equal weighting for other conditions. Resulting time series of activity intensity (in J/min/kg) were summarised into total PAEE (in kJ/kg/day) and time spent on different intensity levels (sedentary as <1.5MET, moderate as 3-6MET, and vigorous as >6MET), whilst minimizing diurnal bias from potentially unbalanced data accumulated over the day. This weighting technique ensures equal representation of all the hours of the day and minimizes the impact of records containing for example 3 nights and 2 days' worth of data. Intensity categories were defined using multiples of RMR as derived using the Oxford equations using age, sex, height, and weight (93). Branched equation modelling of simultaneous accelerometry and heart rate monitoring has been shown to improve estimates of directly measured PAEE. Brage et al, 2004 suggest that individual calibration may be less necessary when branched modelling is employed (91).

After data cleaning, 2,053 recordings from Inuit were available for analysis, corresponding to 63.5% of the total study population. Data were merged with the master database. Four recordings figured only in the AH database and were deleted from further analysis due to the following: One recording was stated with an ID number not identified in the master database and it was not possible to identify the correct ID number from the information on weight, height and CPR number, one recording was from a test person and should not be included in the analysis, two participants were examined twice in two different places and the first record of each participant was deleted.
One recording was recommended by the MRC Epidemiology Unit in Cambridge to be deleted due to a very poor signal. Furthermore, 57 recordings were considered missing because no, or almost no, data were available from the monitor, and therefore data processing was not possible. This might be explained by the participant removing the monitor shortly after it was handed over, poor acceleration signal or noisy HR data. It could be that the monitors were susceptible to interferences from electrical appliances or other sources of static current or that the electrodes were in poor contact with the skin. One recording had missing information on weight.
Recordings were flagged by the MRC Epidemiology Unit in Cambridge for the reason of a poor HR or acceleration signal, SHR estimation problems (no valid data during nights), heart disease or calibration errors. Comments were made to use another estimation model for some of the flagged records. The analyses include flagged recordings unless otherwise stated (see flowchart for cleaning process, table I). If for some reason the combined Acc and HR estimate was deemed invalid, for example due to excessive amounts of noise on the HR channel, the single-measure estimates of PAEE were used to impute such missing values. These were scaled to minimize bias, and scaling factors were derived based on the sample with valid data for both channels. Similarly, a flex HR estimate (84;90) was used if only heart rate data was valid (corrupt and unrecoverable acceleration signal).

A wear time of less than twenty-four hours was presented for 4.8% of the valid AH data. A wear time of more than 48 hours was presented for about 77% of the valid data. In villages 11% did not wear the monitor for more than 24 hours compared with 5% in Nuuk and 2% in towns.

Table l. Proportional differences and odds ratios for participants with and without Acc and HR monitoring > 48 hours.

Characteristics	**Sample without ACC and HR (n=1049)**	**Sample with ACC and HR recordings>48 hours (n=1546)**	**OR(CI95%)**
Sex			
Men	44.4	43.5	1
Women	55.6	56.5	1.04(0.89;1.2)
Place of residence			
Nuuk	5.7	21.4	1
Town	76.1	59.8	0.2(0.20.3)
Village	18.2	18.8	0.3(0.2;0.4)
Age (years)			
18-24	9.9	10.5	1
25-29	7.8	7.8	0.9(0.6;1.4)
30-34	7.7	7.1	0.9(0.6;1.3)
35-39	9.3	10.7	1.1(0.8:1.5)
40-44	11.6	18.9	1.5(1.1;2.1)
45-49	13.2	12.8	0.9(0.7;1.3)
50-54	10.5	10.4	0.9(0.7;1.3)
55-59	7.7	7.6	0.9(0.6;1.3)
60-64	6.8	5.7	0.8(0.5;1.2)
65-69	5.3	4.3	0.8(0.5;1.2)
>70	10.1	4.3	0.4(0.3;0.6)

Table II. Overview of start day of the week presented for total ACC and HR sample and ACC and HR>48 hours.

	Frequency	Percent	Frequency	Percent
	Total sample		>48 hrs of PA data	
Start day of the week				
Monday	309	15.5	246	15.9
Tuesday	346	17.3	277	17.9
Wednesday	354	17.7	260	16.8
Thursday	292	14.6	218	14.1
Friday	287	14.4	232	15.0
Saturday	243	12.2	193	12.5
Sunday	164	8.2	119	7.7
	1995		1945	

Table III. Overview of wear time combined week day and weekend day presented for total ACC and HR sample and ACC and HR>48 hours.

Wear time	N	%
Wear time weekend and week – total ACC and HR sample	1172	58.7
Wear time weekend and week day ≥48 hours	1032	66.8

Table IV. Overview of wear time presented for total ACC and HR sample and ACC and HR>48 hours.

	Mean	Median	Range	IQR
Wear time overall, hours (n=1995)	66	70.6	(2-136)	IQR (49-75.9)
Wear time overall, hours (n=1945)	75	72.7	(48-136)	IQR (48-90.0)

Appendix IV – Overview of IPAQ data processing

Domain	Variabel	Limit	”Value”	Mets (minus BMR)	Activity	Comments
Work	Iht57		Yes/no		Occupational activity outside home	.
	Iht58	0-7	Days	8.0 (7.0)	Vigorous	Hunting and fishing activities not mentioned in activity examples.
	Iht59		Minutes and hours daily			
	Iht60	0-7	Days	4.0 (3.0)	Moderate	
	Iht61		Minutes and hours daily			
	Iht62	0-7	Days	3.3 (2.3)	Walking	
	Iht63		Minutes and hours daily			
Transport	IHT64	0-7	Days	0.0	Sitting/standing	Adapted by adding snowmobile.
	IHT65		Minutes and hours daily			
	Iht66	0-7	Days	6.0 (5.0)	Biking	
	Iht67		Minutes and hours daily			
	Iht68	0-7	Days	3.3 (2.3)	Walking	
	IHT69		Minutes and hours daily			
Domestic	Iht70	0-7	Days			Adapted by adding fetching water and snow shoveling
	Iht71	0-7	Minutes and hours daily daily	5.5 (4.5)	Vigorous	
	Iht72	0-7	Days	4.0 (3.0)	Moderate	Moderate intensity outside and inside is combined into one; Moderate garden activity excluded. Gardening is non-existent and common activities such as getting fishing equipment ready are done both inside and outside the house. Activity examples differ from the Danish version by including care taking and reparation of equipment.
	Iht73		Minutes and hours a day			
Leisure-time	Iht74	0-7	Days	3.3 (2.3)	Walking	
	Iht75		Minutes and hours a day			
	Iht76	0-7	Days	8.0 (7.0)	Vigorous	More activity examples added in the Greenlandic version, such as skiing
	Iht77	0-59	Minutes and Hours a day			
	Iht78	0-7	Days	4.0 (3.0)	Moderate	Activity such as hiking is added
	Iht79		Minutes and hours a day			
Sitting-time	Iht80		Minutes and hours a day	0.0	Sitting week and weekend day	
	Iht81		Minutes and hours a day			

We have used the scoring protocol by IPAQ: http://www.ipaq.ki.se/scoring.htm. Specific rules of truncation and scaling have been added to deal with outliers.

ISSN: 1601-7765
ISBN: 978-87-7899-256-7
ISBN: 978-87-7899-257-4