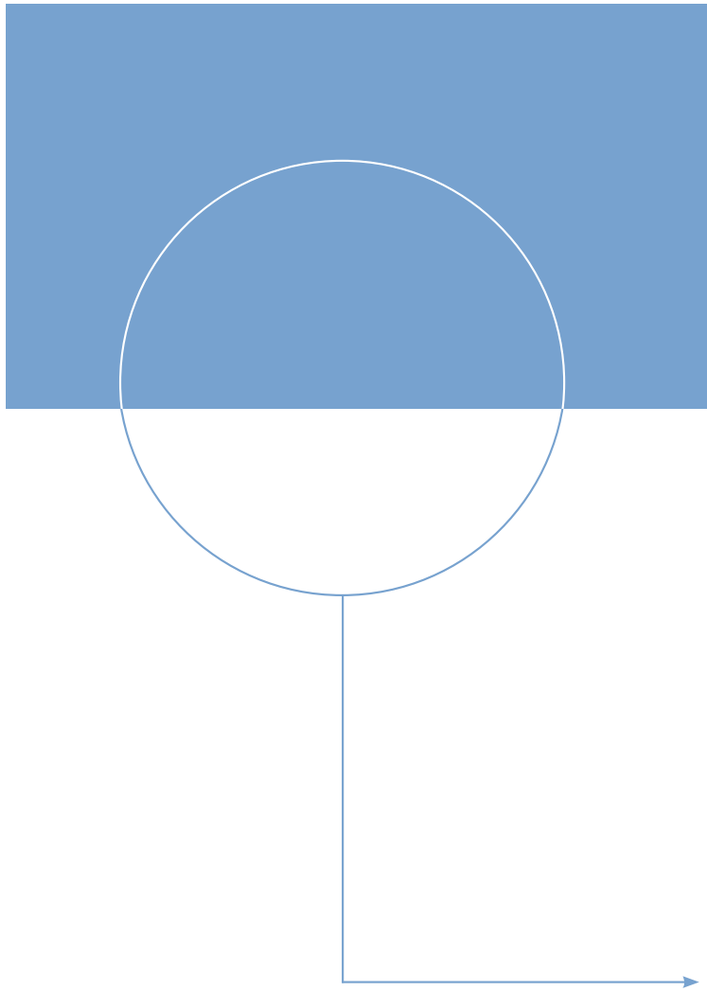

Master's thesis

2021

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Masters of Science in Physical Activity and Health
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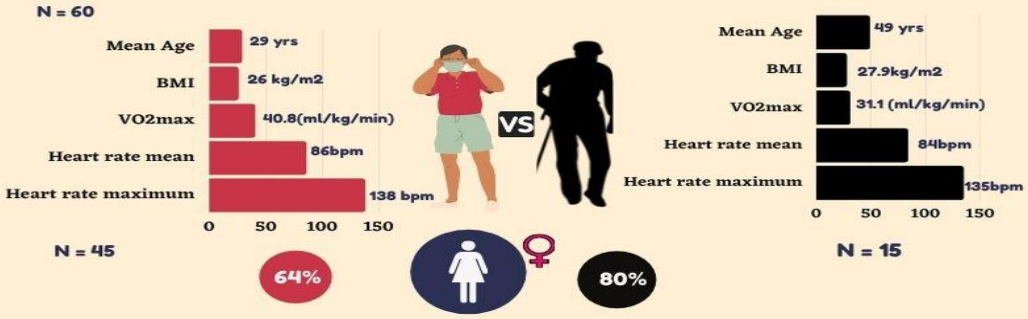
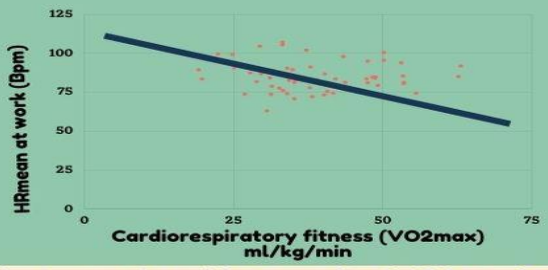
# OBJECTIVELY MEASURED WORK INTENSITY AMONG HOME CARE WORKS; IMPACT AGE

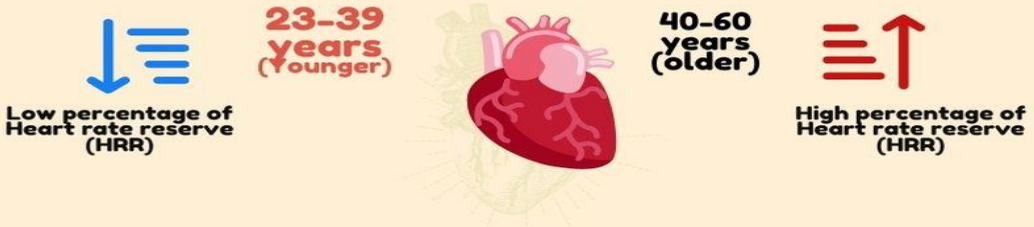
## Descriptive statistics for different age groups among home care workers younger(23-39years) and Older (40-60years)




## Scatterplot showing the relationship between heart rate mean at work(HRmean)and aerobic fitness(VO2max)




## The association between Aerobic capacity (VO2max) and work intensity (HRR at work) stratified by age




## Relative work intensity estimated by RHRmean at work and <33%HRR for Older (⩾35yrs) and younger (⩽35yrs) among home care workers


## CONCLUSION

- AGE HAS AN EFFECT ON THE RELATIONSHIP BETWEEN CARDIORESPIRATORY FITNESS AND AEROBIC WORKLOAD, YOUNGER HOME CARE WORKERS( 23-39 YEARS) SHOWED A LOWER PERCENTAGE OF HEART RATE RESERVE COMPARED TO THE OLDER HOME CARE WORKERS (40-60 YEARS) WITH THE OPPOSITE RESPONSE. HENCE, YOUNGER HOME CARE WORKERS SHOWED BETTER ADAPTATION TO OBJECTIVE MEASURE OF WORKLOAD RELATIVE TO PHYSICAL DEMAND AT WORK COMPARED TO OLDER HOME CARE WORKERS
- AEROBIC CAPACITY IS OF THE YOUNGER HOME CARE WORKER WAS 27% HIGHER COMPARED TO THE OLDER HOME CARE WORKERS
- PHYSIOLOGICAL DECLINE AS A RESULT OF THE IMPACT OF AGE SEEMED TO HAVE CONFERRED AN ADVANTAGE TO YOUNGER HOME CARE WORKERS OVER THEIR OLDER COUNTERPARTS IN TERMS OF SUSTAINABILITY OF HIGH OCCUPATIONAL DEMANDS.

## ABSTRACT

**Purpose** The main aim was to understand if work demands for homecare workers in primary care in a large Norwegian municipality are adjusted according to physical capacity, age, and do older workers spend more time at the higher level of their maximum capacity than the younger workers.
**Methods** (Firstbeat bodyguard 2) heart rate monitor was used to measure aerobic work intensity for 1-6 consecutive working days of at least 4h per day or 75% of whole day work shift. Cardiorespiratory fitness was assessed using a submaximal cycle test (Ekblom bak test). A multivariate statistical regression model was used to assess the relationship between aerobic workload (Heart rate reserve) and cardiorespiratory fitness stratified by age groups among home care workers, adjusting for other confounders.
**Results** There was a negative inverse relationship between aerobic work intensity (HRR) and cardiorespiratory fitness (VO2max) with mean heart rate at work (HRmean)β= -0.24 95% CI (-0.62 to – 0.14), maximum heart rate at work (HRmax) β = -0.34 95% CI (-0.84 to 0.15). When stratified by the age of the home care workers (23-39 years) younger and (40-60 years) older, younger home care workers maintained an inverse negative relationship which did not reach statistical significance β=-2.6 95% CI (-5.5 to 0.26) p=0.0738 and β=-3.5 95% CI (-7.4 to 0.39) p=0.0768, HRmean at work and HRmax at work respectively. However, older workers (40-60 years) showed an opposite outcome which did not reach statistically significance likewise. β=2.6 95% CI (-0.26 to 5.5) and β= 3.5 95% CI (-0.39 to 7.4), HRmean and HRmax respectively.
**Conclusion** Results from this study showed that age has an effect on the relationship between cardiorespiratory fitness and aerobic work load, younger age group of home care workers (23-39 years) showed a decreased percentage heart rate reserve compared to the older age group of home care workers (40-60 years) with the opposite response, thus indicating a higher reserve capacity from the former to sustaining a high occupational demand. Hence, younger age group of home care workers showed a better response to objectively measure of work load relative to physical demand of work compared to the older group of workers

Key words: Ageing, Aerobic capacity, Heart rate reserve, Physical work demands, physical capacity.

## ACKNOWLEDGEMENT

I would like to first of all acknowledge the almighty God who made is possible for me to come this far, my elder sister Mrs. Rose Ogbuchi for the important role she played in facilitating my coming to Norway to pursue an international master's degree program. Secondary, to the two PhD candidates' co-supervisors on this project, Ingeborg Frostad Liaset and Svein Ove Tjosvoll for their feedbacks and support when needed. Lastly my main supervisor Prof. Marius Fimland for his patience and guidance throughout from the inception to the end of the project. Thank you all for the roles played in making the is a reality.

# Table of Contents

## LIST OF FIGURES



## LIST OF TABLES

## LIST OF ABBREVIATIONS

| | |
|---|---|
| **LTPA** | Leisure time physical activity |
| **OPA** | Occupational physical activity |
| **HRR** | Heart rate reserve |
| **HRmax** | Maximum heart rate reserve |
| **HRmean** | Mean heart rate reserve |
| **HRrest** | Resting heart rate |
| **ECG** | Electrocardiogram |

# 1 INTRODUCTION

Physical activity is well cited in the literatures to have a lot of health benefits but these benefits is limited to leisure time physical activity (LTPA)(1). However, there is a growing evidence that occupational physical activity (OPA) is detrimental to health(2). This contradictory health outcome is the so called physical activity health paradox(3). LTPA is characterized by flexible movements at training intensity levels mostly performed voluntarily over a short duration with enough time for recovery (2). In contrast OPA is often associated with repetitive movement over a longer duration with different purpose, design and social context as compared to LTPA (2). The working environment is generally designed with an expectation of productivity, the social organization is conditioned to maximize efficiency and profit with less consideration to the health and well-being of workers, even though many organizations have tried to solve this issue albeit not successful (4).

Home care workers engage in physical activity all year round most times during work and yet it has been reported that they and others in the health care sector have poor health(2). The home care services are part of the public health care and has grown tremendously in past decade owing to the health care reforms (5) and the trend will continue due to the rising number of the elderly people in the western societies (5). The high demand for home care givers is also due to early hospital discharge and patient's preference for home care and community based instead of the institutional care. Home care services play important role in taking care of the elderly, physically as well as mentally challenged individuals, these services are provided in open home service or service apartment house (6, 7). Their job description includes, cleaning, cooking, washing and assisting their clients with other important daily tasks (6).

However, it has been observed that home care workers are more likely than workers in other profession to be granted a disability pension(8) this could be due to physical demands and high occupational injuries associated with their job.(9, 10). Their work demands are characterized by long standing, walking and frequent exposure to awkward postures that subjects them to high risks of overexertion and negative health outcome(7). These could also in part be responsible for the high prevalence of musculoskeletal disorder are the factors that influences work sustainability until retirement age. As the number of sick leave is currently high in Trondheim municipality13.7% compared the national absence 8.5% and 5.9% across other sectors(11), insight into the determinants of sustainable employment gain is essential (12). Employment sustainability in a physically tasking occupation is determined by the balance between work demand and the physical fitness(12). It has been estimated that the percentage of working population between age 45-65 increased from 32.1% in 1990 to 18.4% in 2020. On the other hand, the percentage of active young workers age 15-24 years is expected to decline from 23.1% in 1990 to 18.4% in 2020(13). As the working population get older, working time may be adjusted

accordingly and this could be challenging for older workers in more physically tasking job and that could predispose them to unfavorable health outcome and early retirement(14, 15). Hence there is need

adapt the working demands to the physical capacity of the worker in order to ensure sustainability and improvement in the working condition(16).

Previous studies have shown that workers who are physically fit were protected from adverse effects of high occupational physical activity (OPA) compared to those with low physical fitness, hence high cardiorespiratory fitness is fundamental in understanding the association between occupational physical activity (OPA)and health(17). The physiological mechanism responsible for this protective effective implies that high cardiorespiratory fitness confers a lower aerobic load to fit workers compared to unfit workers when exposed to the similar duty at work(18). Nevertheless, the current body of knowledge is based on previous work done in the laboratory research to assess the aerobic work load during graded exercise(18). Several studies in the past attempted to objectively measure work intensity among home care workers and to evaluate the harmful ergonomic issues relating to occupational physical activity but without consideration of age impact(7).

Aging is characterized by change in body composition, increase in body fat and muscle atrophy which results in decline in muscle strength(19). However, some individual studies and meta-analysis conducted in the 70s and 80s have suggested that work ability does not correlate with aging(20). Nevertheless, these studies were based on laboratory tests. This is a contradiction to previous studies which suggested that job performance is strongly correlated to aging especially for physical demanding job and the deterioration of functional capacity continues throughout life(21). Also, aerobic capacity declines with age, even at higher rate compared to muscle capacity and the rate at which these declined occur especially among workers depends on each individual level of physical activity(22). These physiological declines can be arrested by regular leisure time physical activity (LTPA); however, high occupational physical activity (OPA) does not have long-term training effect on the physical capacity of older workers(22). It has been suggested by previous studies that occupational work demands for older workers and younger workers is the same(23), due to this imbalance in physical capacity as a result of age differences, older workers are more susceptible to negative health outcome(21).

Physical capacity decline as people advances in age, this results in an age-related imbalance between work demand and physical capacity(21). As a result of this, older workers will invariably work at high intensity if they do similar physically demanding occupational activity with relatively higher strain than the younger workers(12). Therefore, this research project is aimed at using objectively measure to ask these research questions: 1) Are work demands for home care workers in primary care in a large Norwegian municipality adjusted according to physical capacity and age, and do older workers spend more time at work at relatively high intensity than the younger workers. 2) Does the physiological decline due to age confer any advantage to younger workers than older home care workers?

# 2 Methods and Analysis

## 2.1 Participant and procedures

A study was conducted on home care workers recruited from 3 different unit in Trondheim municipality in Norway. The data collection was done between October 2020 to December 2020 at three different units at the work places of the home care workers in Trondheim. The study was designed such that participants were included to do their normal routine work during the study. Eligible home care workers (n=66) who had at least 50% shift at work, volunteered to participate in the project, who met the project protocol requirements as follows were invited: (1) Filling the baseline questionnaire including health status questions (2) Objectively measurement of aerobic workload using firstbeat body guard 2 (Firstbeat technologies Ltd, Jyvaskyla, Finland) heart rate monitor across 1-6 consecutive days (3) Cardiorespiratory fitness test using Ekblom bak cycle test(24). Participant were excluded in the study if they did not complete the baseline questionnaire, if they were pregnant or have any sickness that prevented them from exercising, allergy to plasters or bandages were excluded from objective measurement during work and leisure time, participants were excluded from participating from Ekblom bak cycle test if they were being treated for any cardiovascular and lung dieases,exercise induced dyspnea, angina pectoris or any other contraindicators certified by a physician that prevented them from specific cardiorespiratory fitness test. All workers signed and submitted inform consent form prior to participation and are at liberty to quit at any moment they feel uncomfortable. The study was approved by regional committee for medical health ethic (Norway) and conducted in the accordance with Helsinki declaration

## 2.2 Procedures

First, the participants filled and submitted consent form, followed by a short personal assessment to determine if they meet the criteria to participate in the Ekblom bak cycle test and data recording. Data collecting will be done within 24hrs for 6 consecutive days during work and leisure time. Participants who have met the personal assessment requirement will proceed to the submaximal cycle test (Ekblom bak cycle test), anthropometric measurement and objectively measurement of heart rate using fastbeat heart rate monitor.

**Table 1.1** Descriptive statistic and outcome results from home care workers from 3 different units in Trondheim municipality (n = 60)

| | Mean (SD)<br>Median (or n%) | |
|---|---|---|
| Variables | Younger (23-39 years) n =45 | Older (40-60 years) n =15 |
| Age (years) | 29(SD 4.1) | 49(SD 6.7) |
| Sex (n%) Female | 29(64) | 12(80) |
| BMI ($kg/m^2$) | 26(SD 3.4) | 27.9 (SD 5.3) |
| Cardiorespiratory fitness (ml/kg/min) | 40.8(SD 9.9) | 31.1 (SD 9.4) |
| Smoking (n=52)<br>Proportion (%)<br>Never | 66% | 64% |
| Occasionally before | 24% | 18% |
| Occasionally now | 5% | 9% |
| Daily | 5% | 9% |
| HRmean at work | 86(SD10) | 84(7) |
| HRmax at work | 138(SD 12) | 135 (SD 12) |
| Time spent >33% HR | 2.0(SD 1.4) | 1.5(SD 1.1) |

HRmean; Heart rate mean, HRmax; Heart rate maximum, Time spent >33% heart rate(mins)

### 2.2.1 Ekblom bak cycle test and Anthropometric measurement

Anthropometric measurement of home care workers which includes weight and height using a wall mounted SECA 206 measuring tape (SECA Medical Measuring Systems and Scales, Birmingham, UK) was taken to calculate the BMI ($kg/m^2$) before proceeding to the cycle test. The aerobic capacity of each participant was assessed using a submaximal cycle test, Ekblom bak test was done on a bicycle ergometer (Ergomedic model 839E, Monarch, Stockholm Sweden). The test is based on the difference

in heart rate between individual chosen higher work rate and low standard work rate at 4 mins intervals each. The test starts with first 4 mins of cycle on standard and low work rate with participant maintaining 60rpm at 30W, preceded by another 4min of cycling at the individual chosen higher work rate, borg scale of ≈14 RPE was targeted(25). Cycle resistance for each participant is chosen based on gender and fitness level and increased to the next work load after 2 mins, when participants perceive rate of exertion is below the targeted ≈14 on the Borg scale to reach a steady state heart rate above 120bpm. The target heart rate is 120-150bpm (for individuals< 50yrs) and 110–140bpm (for individual ≥ 50 yrs.) respectively(24). The average steady state heart rate during the last minutes of the 2 stages were recorded and the average mean heart observed at 3:15, 3:30: 3:45 and 4:00 at each work rate(25).

### 2.2.2 Heart Rate Reserve and Heart rate Reserve calculation

Percentage heart rate reserve (%HRR) was calculated as the percentage of the range between resting heart rate reserve (HRrest) and maximal heart rate reserve (HRmax) (25). Percentage heart rate reserve (%HRR) is most preferable method to express work intensity relative to resources because it supports the measurement of maximal heart rate during consecutive working hours which estimates the physical demands as well as other stress factors (26). Furthermore, because it employs both the maximal heart rate which is age dependent and resting heart rate which depends physical fitness, hence percentage heart rate reserve (%HRR) is useful among workers of different age and physical capacities (27) Change in heart rate was recorded for 1-6 consecutive days using a portable electrocardiograph (ECG) device, firstbeat body guard 2 (Firstbeat technologies Ltd, Jyvaskyla, Finland). It is made up of 2 standard ECG node that are connected by a short lead clip. The two lead ECG are attached to the chest after skin preparation (shaving off chest hair and cleaning the skin with ethanol solution). One electrode is attached under the collarbone on the right-hand side and the other over any intercostal space on the left side of the ribcage(18). It records change in heart rate at 1ms resolution. The device is not water resistant, as such it cannot be worn to shower or swimming activities. Participants were instructed on how to remove and re-attach the device and provided with extra electrodes (Arbo H92SG) for this purpose. Also, the device can be removed in case of any allergic reaction or if participant feel uncomfortable. Participants were instructed to keep a log of their dairy activities such as wake up time, sleeping time at night, start and end of work time. Home care workers who did not have at least a full day working shift (defined by Gupta et al. 2014 ≥4h day and a total 7h during the entire recording period) were not included in the analysis(26). Based on the working hours, the cut off point for relative aerobic workload was chosen as 33% Heart rate reserve (HRR)(27)

In this study HRRmean (% mean Heart rate reserve) was calculated using the formula

$$\frac{(\text{HRmean-HRrest})}{(\text{HRmax-HRrest})} \times 100$$

HRrest was defined as the lowest heart rate recorded during the whole day measurement. HRmean was the mean heart rate. HRmax was calculated using the formula by Tanaka (208-(0.7 x age)(28).Only beats that are classified as error free are considered in the calculation. (Erroneous beats were defined as beats deviating 15% intervals compared to the nearest beat.

### 2.3.1 Statistical Analysis

All data analysis were conducted using The Statistical package for the Social Sciences (IBM SPSS 26.0, Armonk, NY USA). P-value was set at (<0.05) as statistical significance. To investigate the impact of age on work intensity among home care workers, the association between relative heart rate reserve (HRR) at work categorized as heart rate mean (HRmean), HRmax, proportion of time spent >33%HR at work and cardiorespiratory fitness (VO2max) were assessed using a multivariate regression analysis. Using heart rate reserve as dependent variable and VO2max as a predictor in unadjusted model. Age, BMI, smoking and gender were used as independent variables in the adjusted model.

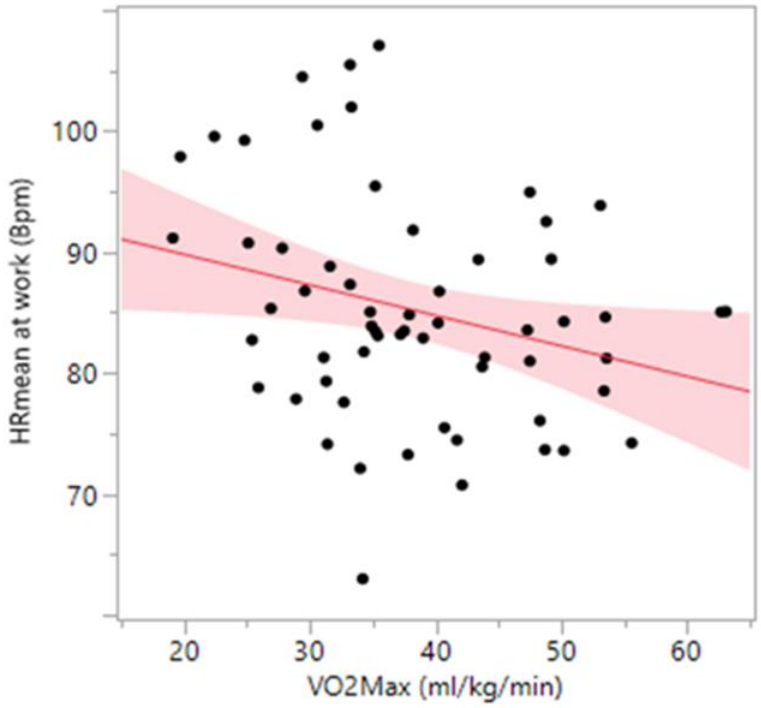



**Figure 1** Scatter plot showing the relationship between heart rate mean at work (HRmean) and aerobic capacity (VO2max)

## 3 Results

Measurements were obtained from n=66 workers who met the set criteria of at least 4hrs of work per day and 7hrs measurement of work for whole day or 75% of average working hour for an individual. The mean age of younger workers 23-39 years was 29 (SD 4.1), older workers age between 40-60 years was 49 (SD 6.7). Proportion of female participants was 64% 23-39 years and 80% 40-60 years. The mean cardiorespiratory fitness (VO2max) for younger home care workers was 40.8 (SD 9.9), the older home care workers had a mean VO2max of 31.1(SD9.4) **fig**.**3** When compared the VO2max of the older female workers (40-60years) 33.1(SD7.1) against the younger female home care workers (23-39 year) 38.4(SD10.8) the difference was statistically significant p=0.0377 **fig**.**3.** However, comparing the younger male home care workers(23-39years) and older home care workers (40-60 years), the later showed a higher mean VO2max value for older workers 45.8(SD 9.4) compared to 41.5 (SD 9.4) P=0.5302. This comparison was skewed in favors of older workers (40-60 years due smaller number of participants n=3 compared to younger home care workers (23-39 years) n=16, hence lower statistical power to detect any difference. Of n=66 home care workers that volunteered to participate in the study, 6 were excluded for erroneous heart rate data and missing data. Hence, 60 participants were included in this analysis. The average maximum heart (HRmax) and mean heart rate (HRmean) for younger homer care workers recorded during working hours was 138bpm (SD12) and 86bpm (SD10)

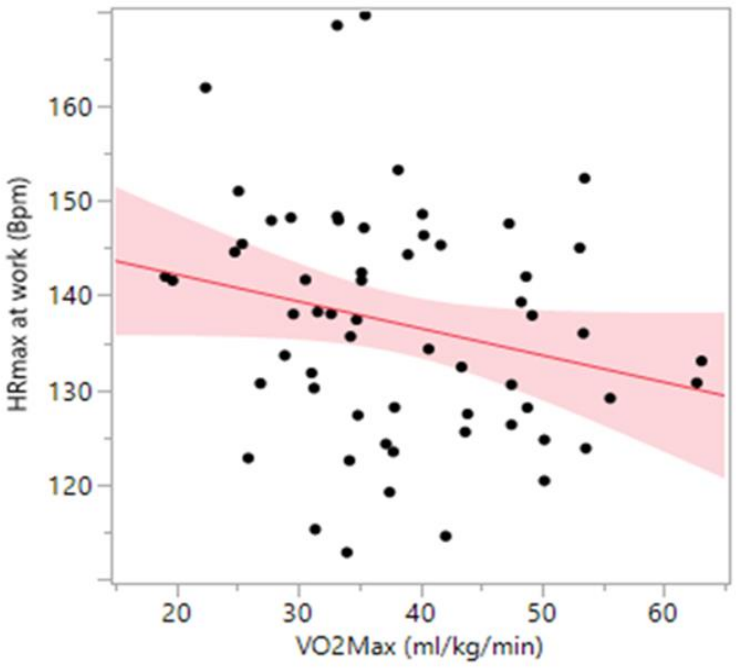



**Figure 2** Scatterplot showing the relationship between maximum heart rate at work (HRmax) and aerobic capacity (VO2max)

respectively. Older home care workers had an average of maximum heart rate (HRmax) of 135bpm (SD12) and 84bpm (SD7) heart rate mean at work (HRmean) respectively. The rest of the descriptive statistics and outcome results of the home care workers is displayed on (**Table 1.1**). **Table 2.1** shows the result of the adjusted multivariate linear regression. In this model, age and sex were adjusted for using HRmean as the dependent variable and aerobic capacity (VO2max) as the predictor. The result showed an inverse relationship **Fig. 1** which did not reach statistically significance β =-0.24 95% CI (-0.62 to 0.14) (p= 0.2104). HRmax at work showed similar pattern **Fig.2** and slightly higher, however, the p value did not reach statistical significance β= -0.34 95% CI (-0.84 to 0.15) p= 0.1777. Time spent >33% HR at work however showed an opposite positive relationship which still did not reach a statistical significance β =0.05 95% CI (-0.01 to 0.1) p = 0.1086. **Table 3.1** shows

**Table 2.1** The association between aerobic capacity (VO2max) and work intensity (HRR at work)

| | Estimates 95% CI | *P-value* |
|---|---|---|
| | Adjusted Analysis | |
| HRmean at work | -0.24(-0.62 to 0.14) | 0.2104 |
| HRmax at work | -0.34(-0.84 to 0.15) | 0.1777 |
| Time spent >33% HRR | 0.05 (-0.01 to 0.1) | 0.1086 |

Adjusted for sex and age, HRmean is the mean heart rate at work, HRmax is maximum heart rate at work, Estimate are β coefficients and 95% CI

**Table 3.1** The association between aerobic capacity (VO2max and work intensity (HRR at work) stratified by age

| | Age groups(years) | | |
|---|---|---|---|
| N=60 | Estimate 95% CI | | *P-value* |
| | 23-39 years (n=45) | 40-60years (n=15) | |
| HRmean at work | -2.6(-5.5 to 0.26) | 2.6(-0.26 to 5.5) | 0.0738 |
| HRmean at work | -3.5(-7.4 to 0.39) | 3.5(-039 to 7.4) | 0.0768 |

HRmean is mean heart rate at work, HRmax is maximum heart rate at work, estimates are β coefficients and 95% CI

the multivariate regression analysis between cardiorespiratory fitness and work intensity (HRR at work) stratified by age groups of the home care workers. The relationship between cardiorespiratory fitness and work intensity (HRR at work) remains a negative inverse relationship with younger age group 23-39 years β=-2.6 95% CI (-5.5 to 0.26) HRmean at work while the older home care workers showed an opposite positive relationship β= 2.6 95% CI (-0.26 to 5.5) p= 0.0738, HRmax at work for both age group showed similar pattern (Table2). β = -3.5 95% CI (-7.4 to 0.39), β = 3.5 (-0.39 to 7.4) p = 0.0786, HRmax for younger home care and older home care workers respectively. Table 4 shows the estimation of the relative work intensity and proportion of time spent >33% HRR between younger age group of home care workers (≤35 years) and older age group (≥35 years). The age group categories were chosen as (≤35 years) younger and (≥35 years) for older to accommodate more younger home care workers as the age the distribution of the participants was asymmetrical in favor of the older home care participants. When compared between older and younger home care workers there is a statistically significant difference in the relative heart rate means (RHRmean) at work, mean difference =2.6, t ratio = 2.1, p=0.0433. Proportion of time spent >33% HRR when compared between older and younger home care workers, the younger workers spent more time at higher percentage of their heart rate reserve compared to the older home care workers mean difference 0.82, t ratio = -2.5, p =0.0144.

**Table 4.1** Relative work intensity estimated by RHRmean at work and Time spent >33%HRR for older (≥35 years) and younger (≤ 35 years) among home care workers

| Age(years) | n (%) | Median | *m*(SD) | min-max | *P-value* |
|---|---|---|---|---|---|
| RHRmean (%) | | | | | |
| Younger (≤35 years) | 40(67) | 44.6 | 45.5 (5.4) | (43.8 – 47.2) | 0.0433 |
| Older (≥ 35 years) | 20(33.3) | 47.4 | 48.1(4.2) | (46.2-50.1) | |
| Time spent>33%HRR | | | | | |
| Younger (≤35 years) | 40(67) | 1.8 | 2.2(1.4) | (1.7-2.6) | 0.0144 |
| Older (≥35 years) | 20(33.3) | 1.22 | 1.3(1.1) | (0.8-1.8) | |

RHRmean: Relative heart rate mean

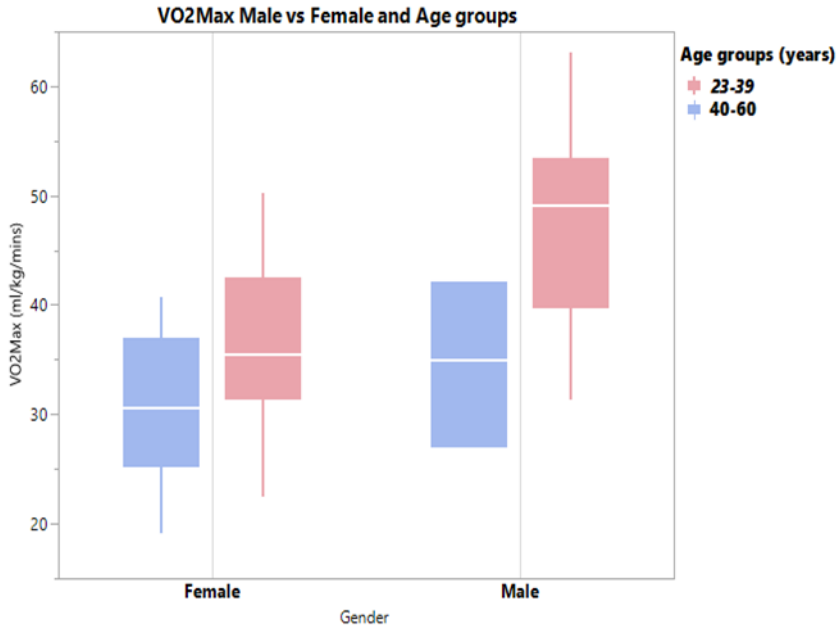



**Figure 3** Box plot showing the relationship between aerobic capacity between younger (23-39 years) and older (40-60 years) stratified by gender

## 4 Discussion

In this study, we objectively measured the work intensity among different age groups among home care workers. The main finding in this study was that age has an effect on relationship between cardiorespiratory fitness and work intensity, younger group of home care workers 23-39 years showed a better response to measure of aerobic workload relative to the physical demand of their work (**Table 1.3)**. In other words, the relationship between cardiorespiratory fitness (VO2max) and work intensity (HRR) when compared between the two age groups, the younger age groups(23-39years) had a lower percentage of heart rate reserve compared the older (40-60 years) home care workers which showed the opposite response. Additionally, the younger home care workers had a higher aerobic capacity 27% difference in VO2max compare the older home care workers.

This results is similar to the findings of the previous study by Steven *et al*.2020(18) suggesting a negative inverse correlation between cardiorespiratory fitness and work intensity however, contrasting with our study, older workers 41-51 years showed a greater effect in their study. The implication of this result is that cardiorespiratory fitness is very essential in sustaining a physically demanding work, as aerobic fitness generally decreases as age increases(29). On contrary, previous results by Tiina Pohjonen, 2001 suggests that aerobic capacity has no influence in work-related capability among female home care workers, also aerobic capacity was not a major factor in determining early retirement among men home care workers(30).

Previous study suggests that age-related occupational physical demand depends on the type of work, older healthcare workers exert themselves at relatively high intensity and this outcome corresponded with their self-reported level of exertion(12). Nevertheless, our result was based on objectively measurement of aerobic work intensity recorded over 6 consecutive working days however, we could draw some similarities from the previous study in the sense that older home care workers in our study may be working at a lower percentage of their heart rate reserve which implies that they have little amount of reserve capacity in heart beat to be able to sustain a high physical demanding occupational job for a long time. Also, in the same study by Merkus *et al.*2019, further results suggest that at group level, older health care workers may have shown poorer physiological response to work performed due to lower aerobic capacity when compared to the younger workers with similar occupational work demands(12). This is similar to the results of our study which showed that when compared by gender, female older workers have lower aerobic capacity compared the younger female older workers. However, even though there was a mean difference in aerobic capacity between the younger and the older male home care workers the difference in aerobic capacity did not reach a statistical significance, probably due to low number of participants thereby providing low statistical power.

Previous study by Oakman *et al*.2019(31) investigating the relationship between age and occupational physical activity found no difference between younger and older workers, hence suggesting that work load is not adjusted according to age or physical capacity(15). However, the difference between younger and older home care workers in our study could be attributed to the aerobic capacity which seemed to be a major factor in sustaining work ability over a long time(32). Previous study has suggested that older workers engaging in physically demanding work are more liable to early retirement(15). However, it is worth noting that there are few studies that have used objective measurement in relations to age and work intensity(31). Previous findings were based on self-reported physical strain unlike objective measurement of work intensity conducted within the working environment over a consecutive working day(31). This study gives an important perspective to objectively measure of work intensity among home care workers, and to the best of my knowledge this is the first of its kinds among home care workers in Norway. Previous study have suggested that comparing between older and younger workers at group category may not give a clear understanding into the age-related imbalance between physical capacity and work intensity at individual level(12). This is because there has been some inconsistencies from the previous studies comparing these age groups(12) and also because methods of assessment employed by difference studies were different(33). There is a further suggestion from the previous study that understanding different levels of physical capacity, work intensity and relative physical stress among older and younger workers and also the insight into the imbalance between physical capacity and work demand at individual level will provide a better feedback necessary to recommend the adequate intervention to sustain work attendance(12, 21). The common denominator among all the previous studies comparing younger and older workers in the similar sector was to finding similar or a better balance between the physical capacity and occupational demand of the worker(12, 34). However, none of these was able to give a sufficient insight to maintaining health or sustaining work(12).

### 4.1 Strengths and Limitations

Main high point of this study was the use of firstbeat guard 2 ECG portable device to objectively measure work intensity among home care workers within 1-6 consecutive day during working hours. To the best of my knowledge, this is the first such study is conducted among home care workers in Norway. However, one of the major limitations could be that the ECG device was not water resistant, participants were instructed to take it off while taking a bath or swimming. This invariable has an impact on the data collection. Also, the sticky part of the 2 lead ECG that was supposed to be attached to the skin were not firm enough to last for the entire duration of the recording hour or during vigorous activity. As a result, there were few cases of missing data or inaccurate heart rate recording. The sample size was small, there were more female than male in this study. Also, there were few older home care workers participants in this study compared to the younger home care workers as result there was an imbalance in age distribution among the participants. Consequently, confidence interval and statistical

significance level was affected. Also, we were not able to include strength testing in this study to be able to measure and compare the strength and muscle activities pattern among the older and younger home care workers. This could have given more insight as to how older and younger home care workers respond to the physical strain and performance to the physical demands of their work.

# 5 Conclusion

This study indicates that age could be influential in assessing the relationship between cardiorespiratory fitness and aerobic work intensity, younger age group of home care workers in this study showed a decrease percentage heart rate reserve compared to the older age group with an increased percentage heart rate reserve, indicating a higher reserve capacity from the later to sustaining a high occupational demand. Hence, younger age group of home care workers showed a better response to the objectively measure of aerobic work load relative to the physical demand of their work compared to the older age group. This result could suggest that work capacity among home care workers in Trondheim municipality is not adjusted according to physical capacity or age, older home care works seemed to be at the negative receiving end of high physically demanding occupation. This study also showed how important aerobic capacity is with regards to sustainability of work participation and moderating aerobic workload among home care workers. Suffice to conclude that physiological decline occasioned by aging process, in this regard the impact of age on VO2max decline could have conferred some advantage on the younger homecare workers over their older counterparts. There is need to adjust occupational work demands for home care workers to suit different age categories, this was a common consensus from the previous studies, and I believe this will serve as an incentive to facilitate longevity at work.

**References**


1. Li J, Loerbroks A, Angerer P. Physical activity and risk of cardiovascular disease: what does the new epidemiological evidence show? Current Opinion in Cardiology. 2013;28(5):575-83.
2. Holtermann A, Krause N, Van Der Beek AJ, Straker L. The physical activity paradox: six reasons why occupational physical activity (OPA) does not confer the cardiovascular health benefits that leisure time physical activity does. BMJ Publishing Group Ltd and British Association of Sport and Exercise Medicine; 2018.
3. Holtermann A, Hansen J, Burr H, Søgaard K, Sjøgaard G. The health paradox of occupational and leisure-time physical activity. British journal of sports medicine. 2012;46(4):291-5.
4. Holtermann A, Coenen P, Krause N. The paradoxical health effects of occupational versus leisure-time physical activity. Handbook of Socioeconomic Determinants of Occupational Health: From Macro-level to Micro-level Evidence. 2020:241-67.
5. Dellve L, Lagerström M, Hagberg M. Work-system risk factors for permanent work disability among home-care workers: a case-control study. International archives of occupational and environmental health. 2003;76(3):216-24.
6. Brulin C, Gerdle B, Granlund B, Höög J, Knutson A, Sundelin G. Physical and psychosocial work-related risk factors associated with musculoskeletal symptoms among home care personnel. Scandinavian journal of caring sciences. 1998;12(2):104-10.
7. Torgén M, Nygård C-H, Kilbom Å. Physical work load, physical capacity and strain among elderly female aides in home-care service. European journal of applied physiology and occupational physiology. 1995;71(5):444-52.
8. Stapelfeldt CM, Nielsen CV, Andersen NT, Krane L, Borg V, Fleten N, et al. Sick leave patterns as predictors of disability pension or long-term sick leave: a 6.75-year follow-up study in municipal eldercare workers. BMJ open. 2014;4(2).
9. Delp L, Wallace SP, Geiger-Brown J, Muntaner C. Job stress and job satisfaction: Home Care Workers in a consumer-directed model of care. Health services research. 2010;45(4):922-40.
10. Denton M, Zeytinoglu IU, Davies S, Lian J. Job stress and job dissatisfaction of home care workers in the context of health care restructuring. International Journal of Health Services. 2002;32(2):327-57.

11. Statistics Norway 2019 [cited 2019. Available from: https://www.ssb.no/arbeid-og-lonn/statistier /syefratot.
12. Merkus SL, Lunde L-K, Koch M, Wærsted M, Knardahl S, Veiersted KB. Physical capacity, occupational physical demands, and relative physical strain of older employees in construction and healthcare. International archives of occupational and environmental health. 2019;92(3):295-307.
13. Auer P, Fortuny M. Ageing of the labour force in OECD countries: Economic and social consequences: International Labour Office Geneva; 2000.
14. Blekesaune M, Solem PE. Working conditions and early retirement: a prospective study of retirement behavior. Research on Aging. 2005;27(1):3-30.
15. van den Berg TI, Elders LA, Burdorf A. Influence of health and work on early retirement. Journal of occupational and environmental medicine. 2010;52(6):576-83.
16. Living EFftIo, Conditions W. Sustainable work over the life course: Concept paper: Publications Office of the European Union; 2015.
17. Holtermann A, Mortensen OS, Burr H, Søgaard K, Gyntelberg F, Suadicani P. Physical demands at work, physical fitness, and 30-year ischaemic heart disease and all-cause mortality in the Copenhagen Male Study. Scandinavian journal of work, environment & health. 2010:357-65.
18. Stevens ML, Crowley P, Holtermann A, Mortensen OS, Korshøj M. Cardiorespiratory fitness, occupational aerobic workload and age: workplace measurements among blue-collar workers. International Archives of Occupational and Environmental Health. 2020:1-11.
19. Zech A, Drey M, Freiberger E, Hentschke C, Bauer JM, Sieber CC, et al. Residual effects of muscle strength and muscle power training and detraining on physical function in community-dwelling prefrail older adults: a randomized controlled trial. BMC geriatrics. 2012;12(1):1-8.
20. Shephard RJ. Aging and productivity: some physiological issues. International Journal of Industrial Ergonomics. 2000;25(5):535-45.
21. Hamberg-van Reenen HH, van der Beek AJ, Blatter BM, van Mechelen W, Bongers PM. Age-related differences in muscular capacity among workers. International archives of occupational and environmental health. 2009;82(9):1115-21.
22. Savinainen M, Nygård C-H, Korhonen O, Ilmarinen J. Changes in physical capacity among middle-aged municipal employees over 16 years. Experimental aging research. 2004;30(1):1-22.

23. Sluiter JK. High-demand jobs: age-related diversity in work ability? Applied ergonomics. 2006;37(4):429-40.
24. Björkman F, Ekblom-Bak E, Ekblom Ö, Ekblom B. Validity of the revised Ekblom Bak cycle ergometer test in adults. European journal of applied physiology. 2016;116(9):1627-38.
25. Ekblom-Bak E, Björkman F, Hellenius ML, Ekblom B. A new submaximal cycle ergometer test for prediction of VO2max. Scandinavian journal of medicine & science in sports. 2014;24(2):319-26.
26. Gupta N, Jensen BS, Søgaard K, Carneiro IG, Christiansen CS, Hanisch C, et al. Face validity of the single work ability item: comparison with objectively measured heart rate reserve over several days. International journal of environmental research and public health. 2014;11(5):5333-48.
27. Krause N, Brand RJ, Kaplan GA, Kauhanen J, Malla S, Tuomainen T-P, et al. Occupational physical activity, energy expenditure and 11-year progression of carotid atherosclerosis. Scandinavian journal of work, environment & health. 2007:405-24.
28. Tanaka H, Monahan KD, Seals DR. Age-predicted maximal heart rate revisited. Journal of the american college of cardiology. 2001;37(1):153-6.
29. Klabunde R. Cardiovascular physiology concepts: Lippincott Williams & Wilkins; 2011.
30. Pohjonen T. Age-related physical fitness and the predictive values of fitness tests for work ability in home care work. Journal of Occupational and Environmental Medicine. 2001;43(8):723-30.
31. Oakman J, Clays E, Jørgensen MB, Holtermann A. Are occupational physical activities tailored to the age of cleaners and manufacturing workers? International archives of occupational and environmental health. 2019;92(2):185-93.
32. Ilmarinen J. Job design for the aged with regard to decline in their maximal aerobic capacity: Part I—Guidelines for the practitioner. International Journal of Industrial Ergonomics. 1992;10(1-2):53-63.
33. Ahlstrom L, Grimby-Ekman A, Hagberg M, Dellve L. The work ability index and single-item question: associations with sick leave, symptoms, and health–a prospective study of women on long-term sick leave. Scandinavian journal of work, environment & health. 2010:404-12.
34. Jebens E, Mamen A, Medbø JI, Knudsen O, Veiersted KB. Are elderly construction workers sufficiently fit for heavy manual labour? Ergonomics. 2015;58(3):450-62.