Low-intensity physical activity benefits blood lipids and lipoproteins in older adults living at home

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Abstract

Objective: to examine the influence of low-intensity, habitual physical activity on blood lipids and lipoproteins and other cardiovascular risk factors in older adults living at home.

Design: cross-sectional observational study.

Participants: a convenience sample of healthy, older adults (n = 155) who were mainly non-Hispanic, white (96.8%), female (65.2%) and on medications for cardiometabolic-related disorders (60.6%) and had an average age of 74.2 ± 0.5 years.

Methods: we used a question from the Yale Physical Activity Survey to assess the typical number of hours per day spent in motion during the past month, collapsing responses into <5 and ≥5 h/day. We determined blood lipids, lipoproteins and glucose with Kodak Ektachem serum oxidase assays or finger stick using the Cholestech LDX system enzymatic technique, and measured blood pressure by auscultation. Waist circumference was the indicator of abdominal fat distribution and body mass index the measure of overall adiposity.

Results: after adjusting for age, sex, adiposity, postprandial state, medication use and method of blood sampling, greater amounts of daily accumulated movement were associated with more favourable blood lipid–lipoprotein profiles. Subjects reporting ≥5 h of daily movement had higher levels of high-density lipoprotein cholesterol [mean difference (95% confidence interval): 0.23 mmol/l (0.07, 0.39); P = 0.002] and a lower ratio of total to high-density lipoprotein cholesterol [average difference: −0.92 (−1.36, −0.48); P = 0.003]. They had lower levels of low-density lipoprotein cholesterol [mean difference: −0.39 mmol/l (−0.80, 0.03); P = 0.074] and a lower ratio of triglyceride to high-density lipoprotein cholesterol [mean difference: −1.31 (−2.50, −0.12); P = 0.059]. Total cholesterol was similar in the two groups (P > 0.05). The mean blood glucose was 1.49 mmol/l lower (−2.67, −0.31) in the more active group (P = 0.02), independent of age, sex, adiposity, medication use and postprandial state.

Conclusions: low-intensity, habitual physical activity is a sufficient stimulus to enhance blood lipids/lipoproteins and glucose in older adults, independent of abdominal and overall adiposity.

Keywords: ageing, blood glucose, exercise, high-density lipoprotein

Introduction

The benefits of physical activity on indicators of cardiovascular health among older adults are often obscured by the confounding effects of adiposity [1]. We found that greater amounts of accumulated, low-intensity physical activity were associated with decreased abdominal fat and blood glucose levels, independent of visceral and overall adiposity in older people at home [2, 3]. These results were intriguing since there is a disproportionate accumulation of adipose tissue with age [4], notably about the abdomen, which confers greater cardiovascular disease risk than overall obesity per se [5, 6]. We did not observe significant associations between self-reported hours of daily movement and total blood cholesterol in these investigations. We attributed this finding to the well-being of the study population, the high prevalence of use of antihypertensive medication and/or selective survival. We did not measure lipoproteins in our earlier work. The possibility remains that they may have been favourably influenced by low-intensity, habitual physical activity.
Participation in regular physical activity is associated with elevated levels of high-density lipoprotein cholesterol (HDL), lower levels of triglycerides and a lower total blood cholesterol−HDL ratio; findings regarding total cholesterol and low-density lipoprotein cholesterol (LDL) have been mixed [1−3, 7−12]. There is considerable controversy about the amount of physical activity needed to produce these beneficial blood lipid/lipoprotein effects. Evidence from exercise intervention studies indicates that healthy, middle-aged adults need to jog approximately 10 miles per week [12−14]. Cross-sectional studies on younger and older athletic populations purport a dose−response relationship, with vigorous endurance exercise exerting the greatest effects [7, 8].

Recently, the positive blood lipid/lipoprotein alterations imparted by physical activity have been reported to occur at lower exercise intensities than previously believed in middle-aged people [15, 16]. Older people are especially vulnerable to the adverse effects of vigorous exercise [17], yet investigations on the influence of low- to moderate-intensity physical activity on the blood lipid−lipoprotein profiles of older people are lacking. Accordingly, we examined the cross-sectional association between self-report of number of hours per day spent moving about—a measure of low-intensity, habitual physical activity—and blood lipids/lipoproteins in a community sample of older adults aged 60 years and older. We also assessed the associations between accumulated, daily physical activity and other cardiovascular health indices, specifically blood glucose, abdominal and overall obesity, and resting blood pressure. We hypothesized that older adults who reported spending greater amounts of time moving about would have better cardiovascular health than those who moved less.

Methods

Subjects

Trained hospital professionals took a series of health screenings, education and counselling programmes to living and social sites in three nontransient, blue-collar communities totalling 129 280 residents. Before choosing to participate in the heart health programme, all volunteers gave written informed consent (as approved by the New Britain General Hospital human studies committee).

Study design

We assessed habitual daily physical movement typical of the past month by the following question from the Yale Physical Activity Survey [18]: “About how many hours a day do you spend moving around on your feet while doing things? Please report only the time that you are actually moving.” The categories of response were \(<1 (n = 1), 1 \to<3 (n = 13), 3 \to<5 (n = 78), 5 \to<7 (n = 56)\) and \(\geq 7 (n = 7)\). Because of the small number of respondents in the lower and higher categories of response, the five categories were collapsed into two: \(<5\) h/day \((n = 92)\) and \(\geq 5\) h/day \((n = 65)\) for the purposes of the statistical analysis. To assist respondents, hospital professionals cited examples of low- to moderate-intensity physical activities. These included light housekeeping, cooking, doing dishes, grocery shopping and leisurely walking and ranged between 2 and 4 metabolic energy equivalents.

The Yale Physical Activity Survey [18] was developed specifically for use with older adults whose preference is to engage in low to moderate physical activity [19, 20].

While completing intake information sheets, subjects sat for a minimum of 5 min. They were asked about their food and liquid intake within the previous 12 h to determine their postprandial state. We defined a fasting state as having had nothing to eat or drink except for water in the previous 12 h for blood lipid/lipoprotein assessments and in the previous 3 h for assessments of random blood glucose [2, 3]. We measured the blood lipid/lipoprotein by venepuncture using the hospital laboratory’s Kodak Ektachem serum cholesterol oxidase assays \((n = 67)\) or finger sticks \((n = 88)\) with the Cholestech LDX system enzymatic methodology (Cholestech, Hayward, CA, USA). Measured total blood cholesterol, HDL and triglycerides values were used to calculate LDL with the Friedewald equation [21]. We assessed all blood glucose determinations by finger stick methodology. Insulin was assessed by the Nichols Institute (San Juan, CA, USA) via radioimmunoassay.

The systematic bias (95% confidence interval) between the Cholestech enzymatic technique and the serum cholesterol oxidase assay for the subsample of 67 was \(-1.96\% (−4.17, 0.24)\). We calculated the systematic bias between the laboratory’s serum glucose oxidase assay and the Cholestech enzymatic methodology on 56 separate blood glucose samples to be 5.42% (4.16, 6.68). The blood lipid/lipoprotein and glucose screening programme is licensed under the hospital’s Department of Laboratory Services and takes part in the College of American Pathologists’ proficiency testing programme.

We measured blood pressure in both arms by auscultation [3]. When the two measurements were within 10 mmHg, we took the measurements made in the arm with the higher systolic blood pressure as the resting systolic and diastolic readings. If the reading in one arm was \(>10\) mmHg higher than in the other arm, we repeated the measurement in the arm with the higher reading until we had two consecutive measurements within 5 mmHg. We then averaged these readings and recorded them as the resting systolic and
diastolic measures. All anthropometric data were gathered with excess clothing and materials removed [3]. Waist circumference (cm) was the measure of abdominal adiposity and the body mass index (kg/m²) the indicator of overall adiposity.

**Statistical analysis**

Descriptive and univariate statistics were gathered on study variables. We tested simple mean differences among study variables by sex and medication use with Student’s independent samples t-test. We used multivariable ANCOVA to determine the association between categories of daily movement (<5 and ≥5 h/day) and blood lipids/lipoproteins while adjusting for age, sex, adiposity, postprandial state and method of blood sampling in the presence and absence of medication use. After adjusting for age, sex, adiposity and postprandial state, the independent association between blood glucose and level of daily movement was tested with ANCOVA including and excluding medication use. We performed all statistical analyses with the Statistical Package for Social Sciences Base 8.0 for Windows 95 and Advanced Statistics Release 8.0, with the Statistical Package for Social Sciences Base 8.0 established as the level of statistical significance [22]. Data are presented as mean values ± SEM.

**Results**

The study sample (n = 155) was mostly white, non-Hispanic (96.8%), women (65.2%) who were unmarried (53.5%) and had a mean age of 74.2 ± 0.5 years. A majority were taking medications (60.6%) for hypertension (n = 81), hyperlipidaemia (n = 27), diabetes mellitus (n = 15) and/or hormone/estrogen replacement therapy (n = 14). Subjects were mainly nonsmokers and did not consume alcohol to excess. Many were poor, with 40.7% reporting an income at or near the poverty level and 43.2% stating that their highest level of educational attainment was completing primary school or less.

The study sample’s physical characteristics are shown in Table 1. Their cardiovascular health profile was above average for people of this age, an observation which is in accordance with our other reports [3]. Compared with the men, the women had higher levels of total cholesterol, HDL and LDL, lower ratios of total cholesterol–HDL and triglyceride–HDL and lower waist circumference and waist-to-hip ratio. Age, body mass index, triglycerides, blood glucose and systolic and diastolic blood pressure did not differ between the women and men (P > 0.05).

The characteristics of participants who were taking medications for hypertension, hyperlipidaemia or diabetes mellitus and/or were on hormone replacement therapy are compared with those of the rest of the group in Table 2. Subjects who said that they took medication for these conditions had higher triglycerides, blood glucose and systolic blood pressure levels, and lower LDL than those who were not medicated for these purposes.

Since the patterns of association between levels of low-intensity physical activity and the various

| Table 1. Mean physical characteristics of the study sample |
|-----------------------------------------------|----------|----------|
| Age (years)                                    | 74.2 ± 0.5 | 73.9 ± 0.6 | 74.8 ± 0.7 |
| Body mass index (kg/m²)                        | 27.2 ± 4.2 | 27.2 ± 0.5 | 27.0 ± 0.4 |
| Waist circumference (cm)                       | 92.1 ± 0.9 | 88.3 ± 1.1 | 99.2 ± 1.1a|
| Waist-to-hip ratio                             | 0.88 ± 0.00 | 0.84 ± 0.4 | 0.94 ± 0.6a|
| Total cholesterol (mmol/l)                     | 5.70 ± 0.08 | 5.98 ± 0.09 | 5.19 ± 0.15a|
| HDL (mmol/l)                                   | 1.32 ± 0.04 | 1.47 ± 0.04 | 1.05 ± 0.05a|
| Total cholesterol–HDL ratio                    | 4.74 ± 0.14 | 4.42 ± 0.15 | 5.36 ± 0.26a|
| LDL (mmol/l)                                   | 3.46 ± 0.08 | 3.61 ± 0.09 | 3.17 ± 0.13b|
| Triglycerides (mmol/l)                         | 2.14 ± 0.10 | 2.13 ± 0.12 | 2.16 ± 0.15|
| Triglycerides–HDL ratio                        | 4.57 ± 0.34 | 4.02 ± 0.41 | 5.61 ± 0.58a|
| Blood glucose (mmol/l)                         | 7.03 ± 0.30 | 6.78 ± 0.34 | 7.52 ± 0.56|
| Blood pressure (mmHg)                          |           |           |           |
| Systolic                                       | 139.7 ± 1.4 | 139.5 ± 1.7 | 140.2 ± 2.4 |
| Diastolic                                       | 77.5 ± 0.7 | 77.8 ± 0.9 | 76.9 ± 1.2 |

HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol.

aP < 0.001, bP < 0.05, cP < 0.01 men versus women.
cardiovascular health indicators were similar in the presence or absence of medication use, findings are presented for the total study sample (Table 3). A larger number of reported hours of moving about was favourably associated with blood lipids/lipoproteins, independent of age, sex, adiposity, postprandial state, medication use and method of blood sampling. Increasing hours of movement were associated with greater HDL, with a mean difference of 0.23 mmol/l (P = 0.002) between ≥5 and <5 h/day of moving about. The total cholesterol/HDL ratio was 0.92 lower (P = 0.003) among those who spent more of their time moving about. This group also had lower levels of LDL and a lower ratio of triglycerides to HDL, with average difference of −0.39 mmol/l (P = 0.074) and −1.31 (P = 0.059). There was no

Table 3. Adjusted* mean (± SEM) levels of blood lipids and lipoproteins and blood glucose by category of daily movement in older adults

<table>
<thead>
<tr>
<th>Mean value, by category of movement</th>
<th>Mean difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥5 h/day</td>
</tr>
<tr>
<td>Total cholesterol (mmol/l)</td>
<td>5.55 ± 0.18</td>
</tr>
<tr>
<td>HDL (mmol/l)</td>
<td>1.45 ± 0.06</td>
</tr>
<tr>
<td>Total cholesterol—HDL ratio</td>
<td>4.18 ± 0.24</td>
</tr>
<tr>
<td>LDL (mmol/l)</td>
<td>3.29 ± 0.16</td>
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<tr>
<td>Triglycerides (mmol/l)</td>
<td>1.72 ± 0.15</td>
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<tr>
<td>Triglyceride—HDL ratio</td>
<td>3.24 ± 0.46</td>
</tr>
<tr>
<td>Blood glucose (mmol/l)</td>
<td>5.92 ± 0.47</td>
</tr>
</tbody>
</table>

CI, confidence interval; HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol.

*Blood lipids—lipoprotein adjusted for age, sex, adiposity, postprandial state, medication use and method of blood sampling. Blood glucose adjusted for age, sex, adiposity, postprandial state and medication use.

bP < 0.01, cP < 0.05, ≥5 versus <5 h/day.
Endurance exercise reverses the age-related deteriorations in glucose tolerance and insulin sensitivity [25, 26]. To characterize better the relationship between blood glucose and low-intensity, habitual physical activity, we measured the fasting levels of plasma insulin in 31 volunteers. Although not achieving statistical significance in the univariate analysis due to insufficient numbers, insulin levels were reduced with increasing amounts of lower intensity movement (20.8 ± 7.3 versus 31.8 ± 7.5 mU/ml for ≥5 versus <5 h/day, respectively; \( P = 0.073 \)). These findings support the contention that participation in habitual, low-intensity physical activity improves insulin sensitivity and subsequent skeletal muscle glucose uptake, which are important precursors of the improved blood lipid/lipoprotein shifts that we observed in this investigation [27].

Once again, we did not observe significant associations between hours of daily movement and systolic or diastolic blood pressure in older adults living at home [2, 3]. Many of the participants (52.9%) were on antihypertensive medications (Table 2), and had resting blood pressures that were well controlled and approached normotensive ranges (Table 1). We made every effort to ensure that the health status of our study sample resembled that of the general older adult population by taking the programme to their homes and social settings. Nonetheless, the overall good health of the study participants may have been responsible for the lack of association between levels of physical activity and resting blood pressure. Another possible explanation is that our measure of moving about was not sensitive enough to detect difference in blood pressure [28].

In summary, low-intensity, daily accumulated physical activity appears to be a sufficient stimulus to improve the blood lipid–lipoprotein profile of older adults at home, independent of visceral and overall adiposity. Likewise, as hours per day of movement increased, blood glucose was lower among these older adults apart from the influences of visceral and overall adiposity. These results are intriguing; however, they do not define the minimum amount of exercise needed to benefit the blood lipid, lipoprotein and blood glucose levels of older adults. Much work remains to be done to quantify more precisely the dose of physical activity necessary for cardiovascular health benefit.

Although still controversial, abnormal plasma lipids/lipoproteins may predispose older people to greater cardiovascular disease risk into advanced age [29, 30]. In addition, the prevalence of sedentary behaviour, cardiovascular disease and its associated risk factors, and medication use increase with age. These occurrences make older adults more susceptible to the negative consequences of vigorous exercise, such as orthopaedic injury, side effects of medications, and sudden death. Older individuals prefer to engage in light to moderate activities such as walking and

Discussion
This study is unique in that it examined the relationship between habitual, low-intensity physical activity and blood lipids/lipoproteins in older adults. Our most important finding is that higher amounts of self-reported low-intensity, regular physical activity were associated with favourable blood lipid–lipoprotein profiles in community-living older adults. As hours per day of moving about increased, HDL levels increased and the ratio of total cholesterol to HDL decreased, regardless of levels of visceral and overall adiposity. Levels of LDL and the triglyceride–HDL ratio also tended to be lower in those who reported greater amounts of daily movement. The unmedicated study volunteers had more favourable cardiovascular risk profiles than those on medications for cardiometabolic conditions. Nonetheless, the beneficial effects of low-intensity, habitual physical activity on blood lipid/lipoprotein and glucose levels prevailed in both groups.

Jogging 10 or more miles per week is required to produce favourable blood lipids/lipoproteins among athletic middle-aged populations [11–14, 23]. Williams [7, 8] and others [11] recently reported a dose–response relationship between the amount and intensity of exercise and blood lipid/lipoprotein alterations in younger and older runners of both sexes. In contrast, our results suggest that habitual, low-intensity physical activity is an adequate stimulus for positive blood lipid–lipoprotein profile changes in older adults living at home. Our observations are consistent with the work of others who have studied non-athletic populations and found that improvements in the blood lipid–lipoprotein profile may occur at lower exercise intensities than previously thought [15, 16, 24]. These findings are encouraging for older adults, who are more vulnerable to the putative effects of vigorous endurance exercise [17] and prefer to engage in familiar physical activities of everyday life [19, 20].

In addition, we detected favourable differences between self-reported hours of daily movement and blood glucose levels. These results agree with our previous reports [2, 3] and suggest possible mechanisms by which low-intensity physical activity improves the blood lipid–lipoprotein profile of older adults.
activities typical of everyday living. For these reasons, regular participation in planned and unplanned lifestyle activities should be recommended for older people to optimize the state of their cardiovascular health.

**Key points**

- Low-intensity, habitual physical activity is sufficient to improve the blood lipid–lipoprotein profile in older adults living at home, independent of abdominal and overall adiposity.
- As hours per day of movement increased, blood glucose decreased in healthy, older people, regardless of visceral and overall adiposity.
- Regular participation in physical activities typical of everyday life should be recommended to older people to optimize their cardiovascular health.

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**References**


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