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## Inverse Relationship Between Physical Activity, Adiposity and Arterial Stiffness in Healthy Middle-aged Subjects

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1 **Title page**

2 *1. Full title*

3 Inverse relationship between physical activity, adiposity and arterial stiffness in  
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3 23 **Abstract**  
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5 24  
6 25 **Background:** Several obesity related factors are reported to exacerbate premature  
7  
8 26 arterial stiffening, including inactivity and metabolic disarray. The aim of the present  
9  
10 27 study was to investigate the relationship between physical activity, arterial stiffness  
11  
12 28 and adiposity using objective methods. To further explore the role of adiposity in this  
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14 29 complex process, obesity associated anthropometric and humoral biomarkers were  
15  
16 30 measured.  
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18  
19 31 **Methods:** Seventy-nine healthy, lifelong non-smoking, subjects were recruited.  
20  
21 32 Habitual physical activity was measured using accelerometry. Arterial stiffness  
22  
23 33 (augmentation index; AIx & pulse wave velocity; PWV), was measured using  
24  
25 34 tonometry. Body composition was estimated using bioimpedence. Adipose associated  
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27 35 biomarkers, leptin and adiponectin, were also measured.  
28

29  
30 36 **Results:** Sedentary time was significantly associated with AIx ( $r=0.38$ ,  $P<0.001$ ),  
31  
32 37 PWV ( $r=0.33$ ,  $P<0.01$ ), body fat composition ( $r=0.40$ ,  $P<0.001$ ) and age ( $r=0.30$ ,  
33  
34 38  $P<0.01$ ). Moderate + vigorous activity was inversely correlated with AIx ( $r= -0.28$ ,  
35  
36 39  $P<0.05$ ) body fat composition ( $r=-0.30$ ,  $P<0.01$ ), postprandial insulin ( $r=-0.35$ ,  
37  
38 40  $P<0.01$ ) and leptin/adiponectin ratio ( $r=-0.28$ ,  $P<0.05$ ). Moderate + Vigorous activity,  
39  
40 41 body fat composition and post prandial insulin remained independent predictors of  
41  
42 42 AIx but not PWV.  
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44 43 **Conclusion:** The more time healthy individuals spend being sedentary, the greater  
45  
46 44 their body fat and arterial stiffness. Conversely higher activity levels are associated  
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48 45 with reduced body fat and less arterial stiffness.  
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5 49 Arterial stiffening is an independent predictor of cardiovascular risk and target organ6  
7 50 damage such as left ventricular hypertrophy, myocardial infarction, renal failure,8  
9 51 retinopathy and vascular dementia.<sup>1</sup> Several factors, such as smoking, metabolic10  
11 52 disease, adiposity and physical inactivity, are reported to accelerate vascular12  
13 53 stiffening.<sup>2,3,4,5,6,7</sup> Many of these factors are inter-related with inactivity predisposing14  
15 54 to adiposity, low-grade inflammation, metabolic disarray and arterial damage.<sup>3,7,8,9,10</sup>16  
17 55 In contrast, when subjects spend more time being vigorously active during18  
19 56 adolescence they have less arterial stiffness in adulthood and the observed benefits are20  
21 57 related to changes in blood pressure, body composition, cardiorespiratory fitness and22  
23 58 their metabolic profile.<sup>6</sup> Consequently activity levels are considered of key24  
25 59 importance in maintaining metabolic and arterial health.26  
27 60 However, many studies examining the impact of physical activity on arterial stiffness28  
29 61 have used subjective questionnaires to quantify activity patterns with few studies30  
31 62 adopting more objective methods such as accelerometry.<sup>2,3,5,6,10,11,12</sup> In addition many32  
33 63 of these studies have focused on subjects in different age/gender groups and in34  
35 64 patients with established metabolic risk factors.<sup>10,11,13</sup>36  
37 65 Therefore, the aim of the present experiment was to simultaneously evaluate the38  
39 66 association between activity levels and arterial wall changes in clinically healthy,40  
41 67 middle-aged subjects, using objective methods. In order to further explore the42  
43 68 complex relationship between physical activity, arterial wall properties and obesity,44  
45 69 we investigated if the interrelationship of activity levels and arterial changes were46  
47 70 correlated with adiposity associated anthropometric, metabolic, hormonal and48  
49 71 inflammatory markers.50  
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**73 Methods**

74 Seventy-nine (51 male & 28 female) subjects were recruited from the general  
75 population via poster advertisements in the local community within a 5 km radius of  
76 the hospital where all the study protocols were performed. The study was approved by  
77 Trinity College Dublin Ethics Committee. Written informed consent was obtained  
78 from all subjects prior to testing protocols. Subjects were included if they were  
79 lifelong never-smokers, free from cardiovascular disease, normotensive (<140/90  
80 mmHg), had normal lipid profile (LDLc <4.0 mmol.L<sup>-1</sup>), normal oral glucose  
81 tolerance test responses (fasting & post prandial glucose <7 & <11 mmol.L<sup>-1</sup>) and  
82 moderate alcohol intake (male <21 units per week; female <14 units per week).  
83 Subjects were excluded if they were receiving treatment for or had a history of  
84 hypertension, hyperlipidaemia, diabetes or were taking any medications that affected  
85 haemodynamic and/or metabolic responses.

86 Following a 12-hour overnight fast, enrolled subjects attended the Cardiovascular  
87 Research Unit at Tallaght hospital. Various anthropometrical measurements were  
88 recorded, including height (Seca 202, SECA, UK), weight (Avery E101, Avery, UK)  
89 and waist circumference (Creative Health Products, USA). Body fat composition was  
90 estimated using whole-body bioimpedance (TBF 410 GS, Tanita, UK).

91  
92 Subjects completed a 2-hour oral glucose tolerance test (OGTT). Blood glucose and  
93 insulin values were measured from venous blood samples before and after a 75g oral  
94 glucose challenge. Homeostasis model assessment (HOMA), a measure of glycaemic  
95 homeostasis, was calculated from fasting glucose and fasting insulin values (fasting  
96 glucose × fasting insulin / 22.1). In addition, for each subject, glycosylated  
97 haemoglobin (HbA<sub>1c</sub>), full fasting lipid profile and the adipose associated blood

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3 98 markers, adiponectin and leptin were measured. Nonspecific markers of systemic  
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5 99 inflammation such as white cell count (WCC) and high sensitivity c-reactive protein  
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7 100 (hsCRP) were also measured to determine the potential impact of adipose associated  
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9 101 inflammation.  
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103 *Pulse wave analysis*

104 The aortic augmentation index (AIx), a measure of wave reflection and surrogate  
105 marker of arterial stiffness, was calculated from pressure waveform measurements  
106 recorded from the radial artery using a previously validated method (Sphygmacor,  
107 AtCor Medical, Australia).<sup>4,14</sup> Central aortic systolic and diastolic blood pressure was  
108 calculated from the radial artery waveform using a previously validated transfer  
109 function (Sphygmacor, AtCor Medical, Australia).<sup>14</sup> The sphygmacor software  
110 automatically generates an “operator index” as an indication of quality control. The  
111 operator index is based on the pulse wave height/shape variation over ten successive  
112 cardiac cycles. In the present experiment, the mean of three values with an operator  
113 index  $\geq 90\%$  were used.  
114

115 *Pulse wave velocity*

116 Pulse wave velocity, a direct measure of carotid-femoral arterial stiffness, was  
117 calculated from simultaneous recordings of the carotid and femoral pressure  
118 waveform using a previously validated semi-automated method (Vicorder, Skidmore  
119 Medical, U.K.).<sup>15</sup> Briefly, two pressure sensitive transducer cuffs were fixed to the  
120 subject’s neck and leg, recording the time delay (Td; ms<sup>-1</sup>) between the carotid and  
121 femoral pulse waveforms using the foot-to-foot method.<sup>15</sup> The distance between the



## Physical activity and arterial stiffness

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3 122 two sites was measured using a tape-measure (Dist; m). PWV was calculated by the  
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5 123 “in-built” software (Td/Dist; m.s<sup>-1</sup>).<sup>14</sup>  
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10 125 *Physical activity*

11 126 A triaxial accelerometer (RT3, Stayhealthy, USA) was used to record routine daily  
12  
13 127 physical patterns. The accelerometer records activity counts as mean acceleration  
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15 128 (m.s<sup>-2</sup>) in the vertical (x), anteroposterior (y) and mediolateral (z) planes. The activity  
16  
17 129 counts are then summarized as vector magnitude (VM=[x<sup>2</sup> + y<sup>2</sup> + z<sup>2</sup>]<sup>0.5</sup>).<sup>16</sup> Physical  
18  
19 130 activity data was recorded at 1 min intervals over seven consecutive days. A day was  
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21 131 defined as the period where 70% of the subjects had recorded accelerometer data and  
22  
23 132 80% of that period constituted a minimal day for inclusion in the data analysis.<sup>17</sup> Data  
24  
25 133 from five consecutive days, including one weekend day (Tuesday-Saturday or  
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27 134 Sunday-Thursday), were used to calculate the absolute and relative time spent being  
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29 135 sedentary and participating in light, moderate and vigorous activity.<sup>18,19</sup>  
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36 137 *Statistics*

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38 138 Pearson’s Univariate correlation and Spearman’s Univariate correlation was used to  
39  
40 139 examine the relationship between parametric and non-parametric data. Stepwise  
41  
42 140 multiple regression was used to assess the relative contribution of chosen variables  
43  
44 141 and arterial stiffness. An unpaired student’s t-test was used to detect differences  
45  
46 142 between groups for normally distributed data and Wilcoxon’s test for non-normally  
47  
48 143 distributed data. Data are presented as mean±SD unless otherwise stated. (JMP  
49  
50 144 Version 4.0, SAS Institute Inc, NC, USA).  
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56 146 **Results**  
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3 147 The physical, metabolic, haemodynamic characteristics and gender comparisons are  
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5 148 outlined in Table 1. Similar to Irish general population averages, 53% of the group  
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7 149 had normal BMI, 38% were overweight and the remaining 9% were obese.<sup>20</sup> In  
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9 150 addition, 48% of the group had a waist/height ratio >0.5 and had high body fat  
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11 151 composition with respect to their age and gender. Gender comparisons revealed that  
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13 152 Augmentation index was markedly higher in females compared to males, yet no  
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15 153 differences in PWV, central BP or brachial BP were observed.  
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21 155 All subjects had normal lipid profile, normal glycaemic profile and normal OGTT  
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23 156 responses. All subjects had normal 24-hour ambulatory blood pressure responses (Sys  
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25 157 <135/Dia <85 mmHg) and normal arterial stiffness with respect to age and gender.<sup>21,22</sup>  
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27 158 The non-specific markers of systemic inflammation, hsCRP and WCC, were also  
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29 159 within normal ranges.  
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34 161 Age was strongly correlated with both AIx ( $r=0.52$ ;  $P<0.0001$ ) and PWV ( $r=0.49$ ;  
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36 162  $P<0.0001$ ). In addition, body fat composition was strongly correlated with AIx  
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38 163 ( $r=0.55$ ;  $P<0.0001$ ) and 24-hour ambulatory diastolic blood pressure was associated  
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40 164 with PWV ( $r=0.25$ ;  $P<0.05$ ).  
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45 166 Mean daily wearing (on) duration of the accelerometer was  $701\pm 91$  min and mean  
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47 167 daily “non-wearing” (off) duration was  $728\pm 90$  min (Figure 1a). Absolute and relative  
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49 168 time spent within activity thresholds can be seen in Figure 1b. Subjects spent  $240\pm 63$   
50  
51 169 min ( $16.71\pm 4.44\%$ ) being sedentary and  $448\pm 90$  min ( $31.06\pm 6.21\%$ ),  $13\pm 14$  min  
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53 170 ( $1.45\pm 2.23\%$ ) &  $4\pm 8$  min ( $0.19\pm 0.35\%$ ) participating in Light, Moderate & Vigorous  
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55 171 activities.  
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## Physical activity and arterial stiffness

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173 The results of the univariate correlation between the relative time spent in the four  
174 activity zones (Sed, Light, Mod & Vig) and physical measures of obesity, arterial  
175 stiffness, blood pressure, metabolic and adipose related humoral markers can be seen  
176 in Table 2. Time spent being sedentary was significantly associated with age, body fat  
177 composition, AIx and PWV. There was a significant inverse correlation between time-  
178 spent being moderately active and body fat composition and fasting insulin.

179 Subjects spent little time participating in moderate activity and 28 subjects did not  
180 spend any time participating in vigorous activity. In an attempt to overcome this  
181 limitation, moderate and vigorous activity time was amalgamated (Mod+Vig) in a  
182 univariate analysis. Mod+Vig activity was inversely correlated with body fat  
183 composition ( $r=-0.30$ ,  $P<0.01$ ), postprandial insulin ( $r=-0.35$ ,  $P<0.01$ ),  
184 leptin/adiponectin ratio ( $r=-0.28$ ,  $P<0.05$ ) and AIx ( $r=-0.28$ ,  $P<0.05$ ).

185 In order to identify the relative contribution of associated variables on arterial  
186 stiffness, age, gender, body fat composition, heart rate, mean arterial pressure and  
187 physical activity were included in two separate stepwise regression models to predict  
188 AIx and PWV. Age, gender, body fat composition and heart rate remained significant  
189 ( $P<0.05$ ) correlates of AIx for all activity zones. The combined Mod+Vig activity, but  
190 not individual Sed, Light, Mod and Vig activity zones, also remained as an  
191 independent predictor of AIx ( $P<0.05$ ). However, age remained the only significant  
192 ( $P<0.0001$ ) predictor of PWV.

193 To further identify the metabolic/hormonal consequences of physical inactivity and  
194 premature arterial stiffening, age, body fat composition, leptin/adiponectin ratio,  
195 postprandial insulin and arterial stiffness indices were included in separate regression  
196 models. Body fat composition and postprandial insulin remained independent

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3 197 predictors of AIx. Again, age remained the only significant ( $P<0.0001$ ) predictor of  
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5 198 PWV.

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10 200 **Discussion**

11 201 The main findings of the study were that subjects who spend more time being  
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13 202 sedentary have stiffer arteries and more body fat. Conversely, subjects that spend  
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15 203 more time being active have less arterial stiffness and lower body fat. Unsurprisingly,  
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17 204 in this healthy population, age remained the strongest predictor of arterial stiffness.  
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19 205 However, body fat composition and postprandial insulin remained independent  
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21 206 predictors of AIx indicating the presence of a disease continuum whereby physical  
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23 207 inactivity and adiposity augment early vascular changes.  
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29 209 Our findings are similar with previous studies using objective methods to quantify  
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31 210 daily physical activity.<sup>3,10,11</sup> Previous studies report that carotid  $\beta$ -stiffness in  
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33 211 postmenopausal women is inversely correlated with time spent participating in low  
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35 212 intensity (<4 MET) physical activity.<sup>23</sup> In addition, further studies report that older  
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37 213 subjects, especially those with low cardiorespiratory fitness, that spend more time  
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39 214 being lightly active (<3 METs) have less arterial stiffness, lower body fat, lower  
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41 215 blood pressure and lower fasting glucose.<sup>24</sup> More recent research reports that physical  
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43 216 activity is an independent predictor of arterial stiffness in hypertensive adults with  
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45 217 varying degrees of metabolic disarray.<sup>10</sup>

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51 219 In the present study, females had significantly higher AIx compared to males despite  
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53 220 no differences in age, heart rate and PWV were observed. Gender differences in AIx  
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55 221 are mainly attributable to differences in height. In shorter individuals, the pulse wave  
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## Physical activity and arterial stiffness

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3 222 path length is smaller, and so, reflected waves coalesce with incident waves at an  
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5 223 earlier time point during systole resulting in greater AIx.<sup>25</sup> These gender differences  
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7 224 are not observed for PWV because it is calculated relative to distance (m.s<sup>-1</sup>).  
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11 226 The link between physical activity and arterial stiffness is complex. Physical activity  
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13 227 can benefit arterial stiffness via its direct effects on the vasculature or indirectly via  
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15 228 exercise induced changes in body composition and associated changes in metabolic  
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17 229 and cardiovascular risk factors.  
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23 231 Physical activity and exercise can directly benefit arterial stiffness and prevent  
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25 232 premature arterial ageing via its effect on blood pressure and heart rate.<sup>26,27</sup> Blood  
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27 233 pressure is one of the major determinants of arterial stiffness. Exercise induced  
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29 234 changes in microvascular structure and function can directly affect systolic and  
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31 235 diastolic blood pressure, thereby improving arterial stiffness.<sup>28,29</sup> Increased heart rate  
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33 236 negatively affects arterial stiffness via the viscoelastic effects of heart rate on the  
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35 237 arterial wall.<sup>30</sup> Increased heart rate is also associated with increased sympathetic  
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37 238 outflow, which is known to stiffen large and medium sized vessels.<sup>31</sup> In the present  
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39 239 study, no significant association was observed between 24-hour ambulatory or central  
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41 240 aortic blood pressure and physical activity and no association was observed between  
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43 241 physical activity and heart rate. These data suggest that the relationship between  
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45 242 physical activity, or lack thereof, and arterial stiffness was not mediated by the direct  
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47 243 effect of activity on the vasculature.  
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3 245 Physical activity can also indirectly impact arterial stiffness via its affect on body  
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5 246 composition and subsequent alteration in adipose related inflammatory, metabolic and  
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7 247 hormonal factors.<sup>6</sup>  
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11 249 Obesity and adipose tissue distribution, specifically increased central/abdominal  
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13 250 visceral adipose tissue, is strongly correlated with increased arterial stiffness.<sup>8,4,32</sup>  
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16 251 Activity induced changes in body fat composition can benefit arterial stiffness via  
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18 252 modification of inflammatory, metabolic and adipose related humoral factors.<sup>6,13,33</sup>  
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23 254 Non-specific systemic inflammatory markers, such as hsCRP and WCC, and adipose  
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25 255 associated inflammatory markers, such as interleukin-6 (IL6), tumour necrosis factor  
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27 256 alpha (TNF $\alpha$ ) and monocyte chemoattractant protein 1 (MCP-1), are associated with  
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29 257 increased adiposity, premature vascular ageing and arterial stiffness.<sup>5,9,34</sup> In the  
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31 258 present study, although the adipocytokines were not measured, hsCRP and WCC were  
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33 259 clinically normal and not associated with any of the activity parameters or indices of  
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35 260 arterial stiffness. These results suggest that abnormal immune responses were  
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37 261 probably not related to the activity related changes in arterial stiffness.  
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43 263 In the present study, all subjects had normal OGTT responses yet postprandial insulin  
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45 264 was inversely associated with time spent being moderately & vigorously active and  
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47 265 independently associated with arterial stiffness. These results suggest that the  
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49 266 relationship between physical activity, arterial stiffness and adiposity may be  
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51 267 mediated via the deleterious affects of adiposity on endocrine function and glycaemic  
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53 268 homeostasis. In support of this, previous studies have consistently reported the  
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## Physical activity and arterial stiffness

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3 269 relationship between abdominal/visceral adiposity, metabolic disorder and arterial  
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5 270 stiffness in both healthy and diseased populations.<sup>35,36</sup>

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9 272 Leptin/adiponectin ratio was associated with time spent being sedentary and moderate  
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11 273 & vigorous activity. The link between adiposity, leptin, adiponectin, metabolic  
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13 274 disarray and cardiovascular disease has been consistently reported.<sup>37,38</sup> Furthermore, it  
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15 275 is suggested that hypertrophy of adipocytes, especially those at key anatomic  
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17 276 locations, results in abnormal paracrine function, disrupting vascular and metabolic  
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19 277 homeostasis.<sup>39,40,41</sup>

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25 279 In summary, the major findings of the present study were that time spent being  
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27 280 sedentary and time spent participating in moderate and vigorous activity was  
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29 281 associated with increased and decreased arterial stiffness and body fat. This is the first  
30  
31 282 study demonstrate the relationship between habitual physical activity and arterial wall  
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33 283 changes in healthy, middle-aged, life-long non-smoking subjects. Furthermore, the  
34  
35 284 results also indicate that adiposity and hyperinsulinaemia may be responsible for the  
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37 285 increased arterial stiffness in less active subjects. Future studies are needed to explore  
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39 286 the protective effect of physical activity and premature arterial stiffening or whether  
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41 287 weight loss alone is sufficient to actuate beneficial changes.

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47 289 A major strength of the present study was that objective methods were used to  
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49 290 quantify daily habitual physical activity patterns. However, arbitrary activity  
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51 291 thresholds were used to determine time spent being sedentary, lightly active,  
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53 292 moderately active and vigorously active. Therefore, the relative intensity of the  
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55 293 activity categories may have differed for the wide age range of subjects (range: 21-59

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3 294 years) that participated in the study. Further studies adopting accelerometry as a  
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5 295 means to examine routine physical activity patterns should consider these factors.  
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10 297 **Funding source**

11  
12 298 This study was partly funded by the Meath Foundation.  
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15  
16 300 **References**

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<b>Physical, metabolic, endocrine, inflammatory and haemodynamic characteristics</b>		
	Male	Female
n	n=51	n=28
Age (years)	38±9	40±9
Height (cm)	177.9±6.7	164.4±5.2
Body mass (kg)	83.1±13.9	64.5±6.8
BMI (kg.m <sup>2</sup> )	26.2±3.7	23.9±2.9
Waist (cm)	91.9±11.8	78.3±6.6
Waist/Height	0.52±0.06	0.47±0.05
Body fat (%)	22.3±6.7	30.1±5.3
Total Cholesterol (mmol.L <sup>-1</sup> )	3.20±0.75	3.07±0.71
Triglyceride (mmol.L <sup>-1</sup> )	1.04±0.43	0.87±0.29
HDLc (mmol.L <sup>-1</sup> )	1.33±0.36	1.66±0.41***
LDLc (mmol.L <sup>-1</sup> )	2.72±0.68	2.67±0.67
Glucose fast (mmol.L <sup>-1</sup> )	5.17±0.39	4.91±0.45
Glucose PP (mmol.L <sup>-1</sup> )	4.77±1.01	4.92±1.20
Insulin Fast (mU.L <sup>-1</sup> )	7.56±2.82	7.37±3.55
Insulin PP (mU.L <sup>-1</sup> )	23.85±28.03	27.52±23.94
HbA <sub>1c</sub> (%)	5.30±0.30	5.21±0.31
HOMA <sub>IR</sub>	1.78±0.70	1.65±0.77
Leptin (pg.mL <sup>-1</sup> .10 <sup>-2</sup> )	118.61±113.40	137.88±78.03
Adiponectin (pg.mL <sup>-1</sup> .10 <sup>-2</sup> )	59.10±27.42	60.68±32.19
Lept/Adipo	2.99±4.97	2.77±1.88
hsCRP (mg.L <sup>-1</sup> )	2.5±2.89	1.30±1.62
WCC (10 <sup>9</sup> .L <sup>-1</sup> )	5.90±1.75	5.87±1.71
24h Brachial Sys BP (mmHg)	119±7	111±9
24h Brachial Dia BP (mmHg)	69±6	66±7
Aortic Sys BP (mmHg)	109±8	105±10
Aortic Dia BP (mmHg)	75±7	71±7
Heart rate (beats.min <sup>-1</sup> )	60±8	63±9
AIx (%)	9.90±11.90	21.75±10.67****
PWV (m.s <sup>-1</sup> )	6.88±0.91	6.89±0.98

466 Table 1. Physical characteristics and risk factors. Body mass index (BMI), waist  
 467 height ratio (waist/height) high density lipoprotein cholesterol (HDLc), low density  
 468 lipoprotein cholesterol (LDLc), postprandial glucose (Glucose PP), postprandial  
 469 insulin (Insulin PP), glycosylated haemoglobin (HbA<sub>1c</sub>), homeostasis model  
 470 assessment of insulin resistance (HOMA<sub>IR</sub>), high sensitivity c-reactive protein  
 471 (hsCRP), white cell count (WCC), 24-hour ambulatory brachial systolic blood  
 472 pressure (24h Brachial Sys BP), 24-hour ambulatory brachial diastolic blood pressure  
 473 (24h Brachial Dia BP), aortic systolic blood pressure (Aortic Sys BP), aortic diastolic  
 474 blood pressure (Aortic Dia BP), augmentation index (AIx), pulse wave velocity

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475 (PWV). \*\* P<0.01, \*\*\* P<0.001, \*\*\*\* P<0.0001 significantly different compared to  
476 males.  
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For Peer Review



478

<b>Univariate analysis of activity and physical, metabolic, endocrine, inflammatory and haemodynamic characteristics</b>					
	Sed	Light	Mod	Vig	Mod+Vig
	r	r	r	r	r
Age	0.30**	-0.11	-0.03	-0.20	-0.13
Body mass	0.06	-0.06	0.06	-0.06	0.10
BMI	0.20	-0.07	-0.04	-0.18	-0.07
Waist	0.18	0.01	-0.08	-0.16	-0.06
W/Height	0.23	-0.01	-0.18	-0.20	-0.16
Body fat	0.40***	0.04	-0.25*	-0.21	-0.30*
Total Cholesterol	0.07	-0.05	0.08	-0.08	-0.14
Triglyceride	0.10	-0.01	-0.20	-0.10	-0.16
HDLc	-0.06	-0.10	0.10	0.02	0.03
LDLc	0.16	-0.03	0.04	-0.11	-0.14
Glucose Fast	0.18	0.01	0.00	0.08	0.01
Glucose Post	0.09	0.01	-0.13	0.06	-0.05
Insulin Fast	0.14	-0.13	-0.14	-0.13	-0.20
Insulin Post	0.19	0.02	-0.25*	-0.21	-0.35**
HbA1c	-0.06	0.18	0.11	-0.03	0.03
HOMA	0.18	-0.14	-0.15	-0.12	-0.20
Leptin	0.27	0.04	-0.17	-0.17	-0.25
Adiponectin	0.05	-0.23	0.16	0.10	0.07
Lept/Adipo	0.23	0.10	-0.26	-0.22	-0.28*
hsCRP	0.04	0.16	-0.10	0.06	-0.05
WCC	-0.05	-0.18	-0.09	0.03	-0.05
24 h Sys	-0.07	0.07	0.12	0.02	0.17
24 h Dia	0.14	-0.01	0.07	-0.14	0.01
Aortic Sys	0.18	0.01	0.01	0.02	0.07
Aortic Dia	0.10	0.00	0.07	0.12	0.13
Heart rate	0.02	0.02	-0.04	-0.13	-0.09
AIx	0.38***	-0.04	-0.17	-0.10	-0.28*
PWV	0.33**	-0.23	0.00	-0.18	-0.12

479 Table 2. Spearman's Univariate analysis of relative time spent being sedentary (Sed),  
 480 lightly active (Light), moderately active (Mod), vigorously active (Vig), combined  
 481 moderate & vigorous activity (Mod+Vig) and indices of obesity, humoral factors and  
 482 arterial stiffness. \* P<0.05, \*\* P<0.01, \*\*\* P<0.001.

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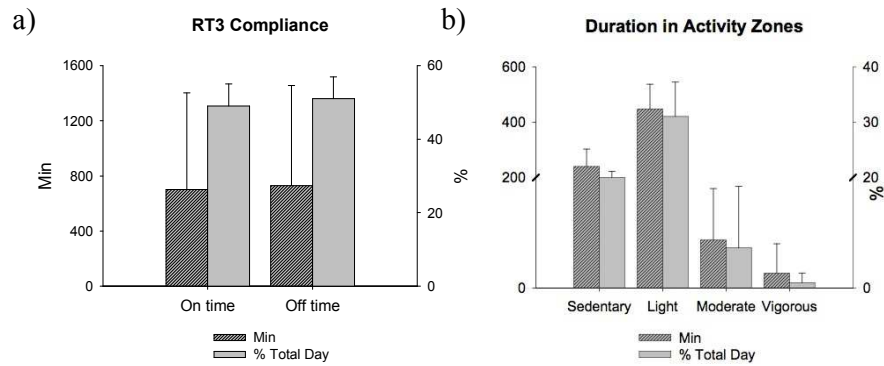
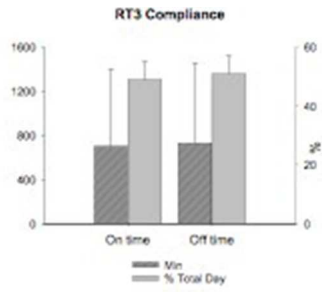


Figure 1. a) RT3 compliance. Absolute (min) and relative (%) time spent wearing (On time) and not wearing (Off time) the RT3. b) Absolute (Min) and relative (%) time spent within activity thresholds. Relative time is expressed as a percentage of an entire day (1440 min). Results are mean $\pm$ SD.

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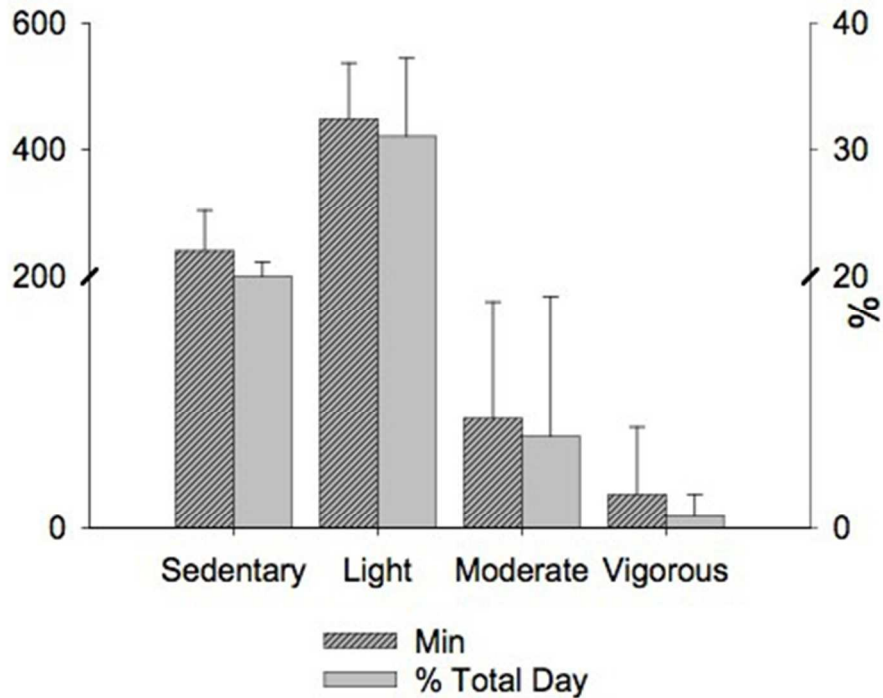


62x50mm (72 x 72 DPI)

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### Duration in Activity Zones



174x143mm (72 x 72 DPI)