Improved metabolic risk markers following two 6 month physical activity programmes among socio-economic marginalized women of Native American ancestry in Lima, Peru

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Short running title. Physical activity reduces circulating glucose

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INTRODUCTION
It is known that ethnicity is a risk factor for diabetes mellitus. Thus, individuals of African, Latin American, and Asian descent are particularly susceptible (1). As an example, a health survey in six urban areas in Peru found a prevalence of diabetes of 17% among women (2,3). It was also found that low socioeconomic status was associated with high burden of non-communicable diseases and appeared as an independent risk factor for diabetes mellitus. In several populations, it is known that increased physical activity reduces the risk for diabetes (4,5). Whether this applies for all populations is, however, not known. The aim of the present study was to explore if supervised endurance training is feasible among socio-economically marginalized women of a poor urban area in Lima, Peru.

RESEARCH DESIGN AND METHODS
The study population consisted of 142 Amerindian women. They were all examined in 1999 (6) and had a normal fasting plasma glucose concentration (range 2.8 – 5.6 mmol/L). Five years later, a total of 83 women participated in a follow-up examination (7). Of these, 76 consented to take part in the present training study. Mean age range was 41 yrs (range 25-64 yrs). The women were randomly assigned into group A (one training session per week) or group B (three training sessions per week). No economic compensation was given besides free athlete suits and shoes.

Exercise training
All the exercise sessions were verified by the direct supervision by a physiotherapist and took place outdoors on a square with concrete surface. A warm-up with stretching, light jogging and flexibility movements was followed by a mixture of traditional folk and modern aerobic dances for a total of 60 minutes. This was undertaken once or thrice per week for 6 months.

Laboratory and clinical measurements
Body weight and height, body mass index, waist circumference, fasting plasma glucose and cardio-respiratory capacity (VO$_2$max) were measured at baseline and after the intervention period. All the subjects refrained from any severe physical activity 48 h before the measurements. Glucose was determined with the glucose oxidase technique. VO$_2$max was estimated indirectly after a running test for 12 minutes around two cones with 20 meters in between, as previously described (8).

Statistical analyses
Comparisons within groups were performed by paired Students’ $T$ test and between groups Mann-Whitney $U$ test. Correlations were performed using Spearman rank correlations and multiple regressions analysis for training sessions, changes of plasma glucose, body weight

BMI, waist circumference and VO2max. A P value of < 0.05 was considered statistically significant.

RESULTS
59 patients completed the study; 33 in group A and 26 in group B. The mean total attendance was 21 in group A (maximal possible 27) and 64 in group B (maximal possible 77). During the 6 month study period, 20 %, in group A (one session per week) and 16 % in group B (three sessions per week) discontinued the training sessions.

Effects of intervention
No significant differences were observed between groups A and B in 1999 before the start of the exercise programme (p> 0.05; Table 1). In both groups, plasma glucose decreased (p<0.01). waist circumference decreased (p<0.05) and VO$_2$max increased
significantly (p<0.05) after the training sessions. These effects were more pronounced among members of group B (p=0.019).

**Correlations**
The number of training sessions was associated with changes in plasma glucose (Rho =0.37, p=0.013), waist circumference (Rho =0.29, p=0.034) and VO$_2$max (Rho=0.38, p=0.009). In contrast, these variables did not correlate significantly with BMI. Multiple regression analysis showed that the number of training sessions and the increase of VO$_2$max independently contributed to changes in plasma glucose, whereas waist circumference and BMI did not correlate significantly.

**CONCLUSIONS**
The dramatic increase of type 2 diabetes in Latin America among subjects with Amerindian heritage (9,10,11) is seen mainly among populations with low socioeconomic status. For prevention and management, these at-risk populations require a tailored approach. This study shows that a supervised physical group activity is feasible among women living in poor urban areas. The attendance rate was high and the drop out rate acceptable. Furthermore, the study shows that following such an activity for six months, circulating glucose and, waist circumference are reduced and VO$_2$max is increased. Furthermore, the number of exercise sessions independently contributed to the reduction of glucose concentrations. In fact, in group B, the mean plasma glucose concentration had decreased to the same level as in 1999. Also in group A, the glucose concentration was significantly reduced, although not to the same degree as in group B.

The exercise regime resulted in a reduction of the waist circumference but with no significant change of the body weight. Exercise in women is associated with a marked increase in lipolysis in the abdominal subcutaneous adipose tissue in comparison with the femoral adipose tissue (12). This suggests that exercise-induced weight loss would be associated with a preferential reduction in abdominal obesity.

Although encouraging, it may be surprising that only one exercise session significantly reduced fasting glucose. This support results that marked changes of the metabolic potential of the muscle occur with small variation in the level of physical activity (13). It is also known that men with impaired glucose tolerance normalize their glucose tolerance by increasing in their weekly physical activity pattern without any change in body weight (14).

The findings in this study that supervised exercise may be a low-cost safe therapy with favourable benefits, not needing to be strenuous or prolonged, and does not having to be done every, are extremely encouraging.

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M. Benavente Ercilla, M. Tamashiro and L. Retamozo at Alternativa Center for Social Research and Popular Education in Lima, participated in design, data collection and provided information to participants.
References

8. Cooper KH: A means of assessing maximal oxygen intake: correlation between field and treadmill testing *JAMA* 1968; 203:201-204.
Table 1. Changes in plasma glucose concentration, body weight, waist circumference, body mass index and cardio-respiratory fitness in 76 women who participated in the aerobic exercise training for six months during 2005. No life style intervention took place between 1999 and 2005. A and B denote group activities one (A) and three (B) times per week.

<table>
<thead>
<tr>
<th></th>
<th>1999</th>
<th>2005 Before training</th>
<th>2005 After training</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plasma glucose (mmol/L)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>4.0±0.4††</td>
<td>5.1±1.7</td>
<td>4.6±1.6**</td>
</tr>
<tr>
<td>B</td>
<td>4.2±0.7†††</td>
<td>5.1±0.9</td>
<td>4.1±1.1***</td>
</tr>
<tr>
<td><strong>Body weight (kg)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>59.0±12.0††</td>
<td>61.4±12.1</td>
<td>60.7±10.7</td>
</tr>
<tr>
<td>B</td>
<td>60.5±11.4†††</td>
<td>64.7±12.8</td>
<td>62.9±11.7</td>
</tr>
<tr>
<td><strong>Waist circumference (cm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>83.0±10.5††</td>
<td>89.7±8.6</td>
<td>89.0±8.8*</td>
</tr>
<tr>
<td>B</td>
<td>85.7±11.5†††</td>
<td>93.0±10.6</td>
<td>90.5±10.6**</td>
</tr>
<tr>
<td><strong>Body mass index (kg/m²)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>25.6±5.0†††</td>
<td>26.9±4.6</td>
<td>26.7±4.3</td>
</tr>
<tr>
<td>B</td>
<td>26.1±5.3†††</td>
<td>27.9±5.5</td>
<td>27.2±5.3</td>
</tr>
<tr>
<td><strong>VO₂ max (ml/kg/min)</strong></td>
<td>ND</td>
<td>19.1±3.9</td>
<td>20.6±4.1*</td>
</tr>
<tr>
<td>A</td>
<td>ND</td>
<td>18.6±3.9</td>
<td>21.7±4.3**</td>
</tr>
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<td>B</td>
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</table>

Data presented as group means ± SD. ND = not done
Values 1999 vs. 2005 before training (p < 0.01††; p < 0.001†††)
Values before vs. after 6 months exercise training (p < 0.05*; p < 0.01**; p < 0.001***)