Metabolic Syndrome and Cognitive Decline: the Role of Physical Activity

M. Rinaldi*[1], G. Graffi [2], E. Rabino Massa[1]

[1] Laboratory of Anthropology, Department of Life Sciences And Systems Biology, Via Accademia Albertina 13, 10123 Torino. *E-mail: marianna.rinaldi@unito.it
[2] ASL TO3, District of Susa, Piazza San Francesco 4, 10059, Susa (TO)

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Abstract

Metabolic Syndrome (MetS) is a cluster of conditions, each of which represents a risk factor for cardiovascular disease: central obesity,hyperglycemia, dyslipidemia and hypertension. Any of these conditions and MetS itself have been associated to Alzheimer's Disease and Vascular Dementia. In recent years there is a growing evidence for the role of physical activity in preventing metabolic diseases and cognitive decline.
In our research we assessed the prevalence of MetS in a sample of 154 elderly people. Furthermore, we evaluated cognition (with Mini Mental State Examination, MMSE) and the physical activity level in every patient.
We found a significant association between MetS, borderline cognitive impairment and sedentary lifestyle.

Introduction

Metabolic Syndrome (MetS) is a cluster of conditions, each of which represents a risk factor for cardiovascular disease: central obesity, hyperglycemia, dyslipidemia and hypertension. MetS can be diagnosed when three or more of these criteria are present [1]: waist circumference ≥102 cm (male) or ≥88 cm (female); triglycerides >150 mg/dl or lipid lowering drugs use; HDL cholesterol <40 mg/dl (male) or <50 mg/dl (female); blood pressure >130/85 mmHg or antihypertensive drugs use; fasting plasma glucose >100 mg/dl or hypoglycemic drugs use. Any of these conditions and MetS itself have been associated to an increased risk of age-related cognitive decline, Alzheimer's Disease and Vascular Dementia [2-6]. The aim of our research was to assess the prevalence of MetS in a sample of elderly people belonging to a rural alpine community and evaluate cognition and the physical activity level of every person to investigate the relationship between MetS, cognitive impairment and sedentary behaviors.
This research has been reviewed and received ethics approval by the Bioethics Committee of the University of Turin.

Materials and Methods

We evaluated 154 persons (84 women and 70 men) aged 60 and over (mean age 74,9±7,8) living in the villages of Venaus, Mompantero and Novalesa (Cenischia Valley, Piedmont). They were recruited through the local healthcare service (ASL TO3) and they all are people whose families have been living in the valley for at least three generations. Blood samples were collected from every study participant in the morning to determine plasma total (TC), High Density Lipoprotein cholesterol (HDL-C), triglycerides and fasting plasma glucose level. Waist circumference, height and weight were also measured.
Moreover, each volunteer was interviewed about his medical history and about some behavioral aspects, in particular physical activity. For the assessment of the physical activity level we considered the amount of light, moderate and vigorous activities each person usually does in a week. Then we divided the sample into three classes:
- *Inactive people*: people who rarely or never do physical activity.
-*Moderately active people*: people who do moderate physical activities (e.g. walking, gardening, housework, yoga, pilates,...) for a minimum of 20 minutes per session for at least three days a week.
-*Very active people*: people who do moderate physical activities for more than three days a week (minimum of 20' per session) and/or a lot of vigorous activities (e.g. working the fields, jogging, mountain trekking,...) every week.
Finally, cognition was assessed with the Mini Mental State Examination (MMSE) [7] which is the most widely used screening test for cognitive impairment. MMSE allows the quantification of cognitive abilities and their changes over time and it has a good reliability (sensitivity = 87%; specificity = 82%). The MMSE total combines scores from five cognitive domains (orientation, language and

comprehension, memory, attention/calculation and praxis), where each domain contributes approximately equal weight to the overall score.
The total score was corrected by age and educational level using the score-adjustment coefficients proposed by Magni and colleagues in 1996. [8]. The maximum score is 30. Scores of 25-30 out of 30 are considered normal. A score lower than 24 is indicative of cognitive impairment (23,9-21,0: mild cognitive impairment; 20,9-10,0: moderate cognitive impairment; <10,0 severe cognitive impairment). A score 24,9-24,0 is considered borderline [7].
All data were entered into Excel® spreadsheets (Microsoft 2007) and analyzed with SPSS Statistics 17.0.

Results

Eighty-two patients had MetS (53,2%). For what concerns cognition: a hundred and twenty seven patients had a normal MMSE score (30,0-25,0), fourteen had a MMSE score less than 24 suggesting cognitive impairment and thirteen had a borderline MMSE score (24,9-24,0) (Table 1).
When we investigated the association between MetS and cognition we found that in the group with metabolic syndrome there were more patients with cognitive impairment (MMSE<24,0) and in particular there was a significantly higher amount of patients with borderline MMSE scores than in the group without MetS (10 vs 3; $\chi2=6,041$; DF=2; $p<0,05$) (Table 1).
When we considered the physical activity level, we found a significant association between MetS and a sedentary lifestyle ($\chi2=9,188$; DF=2; $p<0,01$) (Table 2).
Thus, the prevalence of MetS was greater between inactive people (thirty-three cases out of fourty-six, 71,7%) than moderately active (twenty-four out of fifty-one, 47,1%) and very active people (twenty-five out of fifty-seven, 43,9%) (Table 2).
Then, when we analyze the relationship between cognition and physical activity level, first of all we observe that all the three patients with a severe cognitive impairment fall in the inactive people class (Table 3) and that is due to the serious movement problems associated with severe dementia. If we exclude these three cases from our analysis, we can observe a significant association between borderline cognitive impairment and an insufficient level of physical activity (Table 3): eight out of thirteen patients with borderline MMSE score fall in the inactive people class ($\chi2=13,208$; DF=6; $p<0,05$).
Furthermore, if we exclude from our analysis all the overt cases of cognitive impairment (MMSE<24,0) and consider only borderline and normal MMSE scores (N=140) in relation to MetS and physical activity we find that in patients with MetS borderline MMSE scores are significantly associated with an insufficient level of physical activity ($\chi2=9,398$; DF=3; $p=0,02$) (Table 4).
The standardized residual (R) analysis indicates also that borderline MMSE scores tend to be rarer in people who follow an active lifestyle (moderately active and very active people) and don't have metabolic syndrome.

Table 1. Metabolic syndrome (MetS) and cognition: in the group with metabolic syndrome there are more patients with cognitive impairment and in particular there is a significantly higher amount of patients with borderline MMSE scores ($\chi2=6,041$; DF=2; $p<0,05$).

Cognition	Metabolic Syndrome (MetS)	Normal (No MetS)	Total
Normal (MMSE: 30,0-25,0)	62 (75,6%)	65 (90,3%)	127 (82,5%)
Borderline (MMSE: 24,9-24,0)	10 (12,2%)	3 (4,2%)	13 (8,4%)
Cognitive Impairment (MMSE<24,0)	10 (12,2%)	4 (5,5%)	14 (9,1%)
Total	82 (100%)	72 (100%)	154 (100%)

Table 2. Metabolic syndrome (MetS) and physical activity: in the inactive group there is a significantly greater number of people with MetS ($\chi2=9,188$; DF=2; $p<0,01$).

Physical Activity	Metabolic Syndrome (MetS)	Normal (No MetS)	Total
Inactive	33 (40,2%)	13 (18,1%)	46 (29,9%)
Moderately active	24 (29,3%)	27 (37,5%)	51 (33,1%)
Very active	25 (30,5%)	32 (44,4%)	57 (37,0%)
Total	82 (100%)	72 (100%)	154 (100%)

Table 3. Physical activity and cognition: all the patients with a severe cognitive impairment fall in the inactive class because of the serious movement problems associated with severe dementia. Moreover, there is a significant association between borderline cognitive impairment and an insufficient level of physical activity: 8 out of 13 patients with borderline MMSE scores fall in the inactive class ($\chi 2$=13,208; DF=6; p<0,05). (C.I.= cognitive impairment).

Cognition	Physical Activity			Total
	Inactive	*Mod. active*	*Very active*	
Severe C.I. (MMSE<10,0)	3 (6,5%)	0 (-)	0 (-)	3 (1,9%)
Moderate C.I. (MMSE: 20,9-10,0)	1 (2,2%)	1 (2,0%)	0 (-)	2 (1,3%)
Mild C.I. (MMSE: 23,9-21,0)	4 (8,7%)	1 (2,0%)	4 (7,0%)	9 (5,8%)
Borderline (MMSE: 24,9-24,0)	8 (17,4%)	3 (5,9%)	2 (3,5%)	13 (8,4%)
Normal (MMSE: 30,0-25,0)	30 (65,2%)	46 (90,2%)	51 (89,5%)	127(82,5%)
Total	46 (100%)	51 (100%)	57 (100%)	154 (100%)

Table 4. Metabolic syndrome (MetS), physical activity and cognition: in patients with MetS borderline MMSE scores are significantly associated with an inactive lifestyle ($\chi 2$=9,398; DF=3; p=0,02). The standardized residual (R) analysis indicates also that borderline MMSE scores tend to be rarer in people who follow an active lifestyle and don't have MetS. (Here the active category includes moderately active and very active people).

Cognition	MetS		NO MetS		Total
	Active	*Inactive*	*Active*	*Inactive*	
Borderline MMSE score	4 (8,9%)	6 (22,2%)	1 (1,8%)	2 (18,2%)	13 (9,3%)
Normal MMSE score	41(91,1%)	21 (77,8%)	56 (98,2%)	9 (81,8%)	127(90,7%)
Total	45 (100%)	27 (100%)	57 (100%)	11 (100%)	140 (100%)

Discussion

In recent years there has been a growing interest in the relationship between sedentary lifestyle and health outcomes. Several studies have highlighted the health risks associated with high sedentary time, in particular increased risk for type 2 Diabetes Mellitus, cardiovascular diseases and even for cancer [9-11]. A recent meta-analysis have reported that greater time spent sedentary increases the odds of MetS by 73% (OR 1.73; 95% CI=1.55–1.94; p<0.0001) [12].

At the same time, MetS has been showed to increase the risk of age-related cognitive decline [3], Alzheimer's Disease [4-5], Vascular Dementia [6] and the risk of progression from mild cognitive impairment (MCI) to dementia [13].

On the other hand, some researches document significant benefit of long-term, regular exercise on cognition, dementia risk and perhaps dementia progression [14].

A recent meta-analysis attests significant cognitive benefits from sustained exercises in healthy adults, especially in memory, attention, processing speed and executive function [15]. In cross-sectional analyses, physically fit seniors performed significantly better on cognitive tasks than unfit seniors and had functional brain MRI evidence of significantly better cortical connectivity and activation during cognitive tasks [16-17]. A 6 month randomized controlled trial of aerobic exercise in seniors without dementia was associated with increased cortical volumes compared with sedentary interventions [18]. Furthermore, adults who routinely engaged in physical activities, sports, or regular exercise in midlife carried a significantly lower risk of dementia years later [19]. In addition, there are some studies that documented improved cognitive scores in seniors with mild cognitive impairment (MCI) or dementia [20-21].

Conclusions

Our results show a significant association between metabolic syndrome, age-related cognitive decline and a sedentary lifestyle and they are consistent with an evolving international literature that documents benefits of regular physical activity on health and cognition.

We intend to continue this study on a larger sample with a 12 months follow up to determine if there are differences in the progress of cognitive decline among active and inactive people.

Promoting physical activity in aging adults could be an important tool to prevent cognitive impairment and improve health and quality of life in late life.

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