

# Determinants of Metabolic Syndrome in the Workplace of the National Electricity Company in Kinshasa, Democratic Republic of Congo



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## Abstract

**Background:** Non-communicable diseases (NCDs) and chronic diseases such as cardiovascular disease (CVD), chronic respiratory conditions, diabetes, cancer, and musculoskeletal disorders are multifactorial and disabling diseases. They have become a real burden globally [1-5]. Indeed, metabolic syndrome is a warning sign of a serious health problem in the workplace. It witnesses the significantly increased risk of developing type 2 diabetes and/or cardiovascular disease-causing disability, reduced production, and premature death.

**Aims:** To identify the factors associated with the metabolic syndrome in SNEL workers in the city of Kinshasa.

**Methods:** longitudinal study for analytical purposes carried out among agents of an electricity company in the city of Kinshasa. The data collection was based on a questionnaire, a clinical examination, and a laboratory assessment.

**Results:** 92 agents responded to the summons, or 65.5%. The risk factors associated with metabolic syndrome in SNEL employees before the procedure are: sex (OR=9.9), marital status (OR=0.24), function, tobacco consumption (OR=1.23), history of arterial hypertension (HBP) (OR=1.29), history of CVD (OR=0.59) and history of type 2 diabetes (T2D), (OR=0.01), healthy diet (OR=26.5), quality of life (OR=1.3) and recreational physical activity (APL) (OR=1.28). After the intervention, it emerges from the same table that the RF associated with the metabolic syndrome in SNEL employees are: age (OR=0.48), level of study (OR=3.09), function (OR=3.09), sedentary lifestyle (OR=0.445), tobacco (OR=0.21), alcohol (OR=0.20), history of hypertension (OR=0.33), history of CVD (OR=0.26), Quality of life (OR= 9.87), healthy diet (OR=1.9) and APL (OR=1.7).

**Conclusion:** This study made it possible to objectify the extent of the metabolic syndrome and the associated RFs. He witnesses the significantly increased risk of developing NCDs in sedentary workers with an impaired quality of life. These results call for the urgent implementation of targeted preventive and therapeutic strategies for the metabolic syndrome in order to combat the emergence of chronic and non-communicable diseases.

**Keywords:** Metabolic syndrome; Associated factors; Kinshasa

## Introduction

According to projections, in 2030 CVD will be responsible for more than 23.6 million deaths worldwide [7]. In developing countries, they will be responsible for more deaths than the sum of infectious, nutritional, maternal and perinatal diseases [8]. In addition, CVD is the leading cause of death in diabetics. The progression of these insidiously progressive diseases is associated with the prevalence of obesity, which has almost

doubled in adults over the past 30 years [9]. They are the result of interactions between a set of well-known non-modifiable (sex, age, ethnicity) and modifiable risk factors (RF) including physical inactivity (PI), smoking, excessive alcohol consumption and poor diet (low intake of vegetables and fruits) [10-13] in a context of urbanization, rapid industrialization and health transition (epidemiological, demographic, nutritional). Indeed, changes in the global food system have led developing countries

(DCs) into a nutritional transition characterized by a diet that is westernized and an increasingly sedentary lifestyle, factors that all contribute to modulating the prevalence. obesity and its metabolic and cardiovascular consequences (hyperglycemia, hypercholesterolemia, arterial hypertension, visceral obesity), in populations and in individuals [6,14-17].

The constellation of three or four of these risk factors in an individual are well identified and constitute a pathological entity called metabolic syndrome (Smet) which is currently a public health problem in the world. Globally available data indicate that 20% to 30% of the adult population has metabolic syndrome [6]. The prevalence of Smet and its manifestations varies from 10 to 30% in industrialized countries depending on the definition used to determine it, the age of the group studied, the sex and the ethnicity of the participants in the different studies [5,18-19]. In the United States, it affects about a fifth of the adult population and in Europe almost a quarter. This is an evolving phenomenon, the number of patients with Smet in the world was 150 million in 2000 and, in the absence of essential primary prevention measures, it will reach 235 million in 2025. WHO says “most” Africans are prone to at least one of the major risk factors for NCDs?

Several studies report very high and increasing rates of these factors of MCR, Smet, obesity, diabetes mellitus and CVD in the workplace in SSA [18,20-26]. NCDs in general and CVD are growing rapidly in low- and middle-income countries, as there is no integrated primary health care program for the detection of metabolic syndrome and treatment of individuals at risk unlike to PD. The DR Congo is not spared by this global epidemic, it responds to practically the same changes in living conditions observed in the world. However, there is little work on this association in the population of DR Congo in general and in the workplace. NCDs are already established as a public health problem in the Democratic Republic of Congo (DRC), both in hospitals [27-30], in the population [31,32] and in the workplace [33-34].

Indeed, all the epidemiological studies on the Congolese population in these different environments have described a population in nutritional, demographic and epidemiological

transition, and characterized by a high risk of developing chronic non-communicable diseases in general and CVD in particular. Studies carried out at the National Electricity Company (SNEL) indeed note a predominantly inactive and sedentary working population with a low quality of life (QOL). In an earlier SNEL population study, NKOY observed a very high rate of physical inactivity estimated at 61.9% and a rate of 72.9% of stressed employees [35]. In addition, in the same study, a positive association between the rate of stressed employees and the category with high socioeconomic level was highlighted. ONYUMBE [36] noted an estimated mortality rate of 35.3% for all departures during the period from 1990 to 2003 within SNEL.

There is a high concentration of two-thirds of the active agents of SNEL in the age group between 40 years and 54 years, raising a population in advancing age and at risk of developing CVD. During daily work in the SNEL rehabilitation service, between 2003 and 2007, the KIKONTWE team (candidate for this thesis) noted that the number of cases of diabetic neuropathy, morbid obesity, musculoskeletal disorders -skeletal, physical deconditioning, high blood pressure and that of employees suffering from cerebrovascular accident (CVA) respectively increased from year to year and the cases of premature death became more and more frequent. These supposedly considerable clinical consequences of MCR in the SNEL workplace, especially in terms of SMET, are not yet attributable to BP, healthy diet, and quality of life.

Method

The study is longitudinal for analytical purposes, we followed up on the employees of the National Electricity Company in the city of Kinshasa province, managers and non-managers combined being on the list of staff as provided by the Human Resources Department. For three years, during the period from 06 November 2007 to 10 October 2010. In addition, the sampling for this study is accidental non-probability. The agents were selected according to the order of their arrival at the offices of Occupational Medicine or at the SNEL Polyclinic located on Avenue de la Justice in the commune of Gombe. Therefore, a sample of 92 agents was selected based on the inclusion criteria (Table 1).

Table 1: The metabolic syndrome variable takes into account the parameters.

Parameters	FID	New Composite
Abdominal obesity	Waist circumference M ≥ 94 cm F ≥ 80 cm	Waist circumference H ≥ 94 cm and F ≥ 94 cm
dyslipidemia	TG ≥ 1.7 mmol/L	HCT ≥ 5.2 mmol / L
	HDL : H < 1 mmol/L	
	F < 1.3 mmol/L	
Dysglycemia	Blood glucose ≥ 5.6 mmol/L	Blood glucose ≥ 5.6 mmol/ L
Blood pressure	SBP ≥ 130 mmHg	SBP ≥ 120 mmol/ L et
	DBP ≥ 85mmHg	DBP ≥ 80 mmol/ L
Diagnostic criteria	3 criteria out of 4	3 criteria out of sur 4

In addition, a pre-established and pre-coded data collection sheet as well as validated and adapted questionnaires were used for the annotation of the parameters of interest collected according to techniques, tests, and standardized scores. In addition, with regard to the variables, the dependent variable is the metabolic syndrome, which is a dependent variable built on the basis of the approach to the definition of FID modified by the author of the present thesis by considering at least three criteria to diagnose metabolic syndrome. The metabolic syndrome variable considers the parameters: for abdominal obesity: waist circumference according to local thresholds; for high total cholesterol, dysglycemia, and high blood pressure (SBP and DBP) according to WHO [37]. Thus, we will have two modalities namely:

- a. Yes: presence of metabolic syndrome
- b. No: No metabolic syndrome

The independent variables are grouped into two categories, the non-modifiable and the modifiable. Non-modifiable independent variables (sex, age, family history of hypertension, T2DM and CVD) and modifiable variables These are the anthropometric measurements of the SNEL employee collected at the time of the survey, at the start and in end of intervention for the two interventions, in particular: anthropometric, clinical and biological data, as well as the composite variable on quality of life, healthy diet and physical leisure activity.

The intervention consisted of health promotion in terms of moderate free physical activity and healthy eating supported by therapeutic education of the patient in primary prevention, over a period of three years. The recommended healthy diet was a diet rich in fruits and vegetables, fish, and white meat, low in fat, various cold cuts, salt and red meat. As for BP, it was recommended

that they reduce the time of sedentary behaviors, increase the volume of BP, especially APL, reduce alcohol consumption and stop smoking. Finally, personalized advice was provided for the management of quality of life.

After data entry using EPI DATA 3.0 software, the data was and analyzed using SPSS 25.0 software. Indeed, within the framework of this study we used two statistical analyzes of the data: univariate and multivariable analyzes. As for the univariate analysis, the qualitative variables are grouped together in the form of tables of frequencies and for the quantitative variables data are summarized as the mean with standard deviation when the distribution is symmetric or otherwise by the median. and its interquartile space. For multivariate analysis, the binary logistic relationship is used to determine the risk factors for Metabolic Syndrome. In short, all the analyzes for the modifiable variables were carried out in two phases, before the intervention and after the intervention.

**Result**

For the univariate analysis, based on the selected sample, table 2 shows that with regard to gender, 72.8% of employees are men; for age, the mean age is 51.6 years with a standard deviation of 7.5 years. Regarding marital status, 76.1% of employees have married marital status, 78.3% have university level. In the end, for the function, 79.3% of SNEL employees are bureaucrats. Table 3 shows that 51% of agents are sedentary, 47% who consume tobacco, 53% consume alcohol, 50% had a personal history of hypertension, T2D or CVD and 52% had a family history of hypertension, T2DM or CVD. Table 4 shows before the intervention, there were 22% of the agents who had good quality of life and there is a strong improvement of 51% after the intervention.

**Table 2:** Distribution of participants according to socio-demographic characteristics.

Variables and modalities	N = 92	%
<b>Gender (sex ratio = 2.7)</b>		
Male	67	72.8
Female	25	27.2
<b>Age (year) (X̄ = 51.6 ± 7.5)</b>		
31 - 40	9	9.8
41 - 50	27	29.3
51 - 60	45	48.9
61±	11	12
<b>Marital status</b>		
Single	17	18.5
married	70	76.1

widower	1	1.1
divorced	2	2.2
separated	2	2.2
<b>Education level</b>		
University	72	78.3
Secondary	15	16.3
Primary	5	5.4
<b>Function</b>		
Bureaucrat	73	79.3
Technician	15	16.3
medical staff	4	4.3

**Table 3:** Distribution of agents according to their personal and family characteristics.

Factors	n=92	%
Sedentary life style	47	51
Tobacco	43	47
Alcohol	49	53
Personal history	46	50
Family history	48	52

**Table 4:** Distribution of the quality of life, healthy food, leisure-time physical activity before and after the intervention.

Variables	Before Intervention (n=92)	After Intervention (n=92)	p
<b>Quality of life</b>			
Good	20 (22.0)	47 (51.0)	0.04
Bad	72 (78.0)	45 (49.0)	
<b>Healthy food</b>			
Good	15 (16.0)	56 (61.0)	0.02
Bad	77 (84.0)	36 (39.0)	
<b>Recreational physical activity</b>			
Yes	52 (57.0)	70 (76.0)	0.003
No	40 (43.0)	22 (24.0)	

In addition, there is a statistically significant relationship between the quality of life before and after the intervention at the 5% level. Before the intervention, there were 16% of the workers who had the right healthy diet and there is a strong improvement of 61% after the intervention. In addition, there is a statistically significant relationship between healthy eating before and after the intervention at the 5% level. Before the intervention, there were 57% of the agents who engaged in recreational physical activity and there is a strong improvement of 76% after the intervention. In addition, there is a statistically significant relationship between the APL before and after the intervention at the 5% level.

For the multivariate analysis, before the intervention, it

emerges from Table 5 that the factors associated with the metabolic syndrome in SNEL employees are: sex, marital status, function, tobacco consumption, personal history and family hypertension, CVD and T2DM, healthy diet, quality of life and physical activity for leisure. Indeed, about sex, there is an equal chance that male agents have the metabolic syndrome compared to female agents ( $p=0.000$ ,  $OR=1.28$ ). Regarding marital status, agents who live outside a union are 10 times more likely to develop the metabolic syndrome compared to those who are in a union ( $p=0.002$ ,  $OR=9.9$ ). For function, there is 76% less chance than SNEL employees who are non-bureaucrats to have the metabolic syndrome compared to bureaucratic employees ( $p=0.003$ ,  $OR=0.24$ ).

**Table 5:** Risk factors associated with metabolic syndrome before and after the operation.

Variable and modality	Before the Intervention			After the Intervention		
	Coefficient	p-value	OR	Coefficient	p-value	OR
<b>Sex</b>						
Male			1			1
Female	0.25	0	1.28	0.111	0.528	1.12
<b>Age</b>						
<40 years			1			1
≥40 years	1.2	0.07	3.32	1.13	0.009	3.09
<b>Marital status</b>						
In union			1			1
Outside union	2.3	0.002	9.97	-0.083	0.547	0.911
<b>Study level</b>						
High			1			1
Low	-0.43	0.234	0.65	-0.739	0.008	0.478
<b>Function</b>						
Bureaucrat			1			1
No bureaucrat	-1.42	0.003	0.24	-0.45	0.001	0.64
<b>Sedentary life style</b>						
Yes			1			1
No	-1.11	0.06	0.33	-0.81	0.008	0.445
<b>Tobacco</b>						
Yes			1			1
No	0.22	0.005	1.25	-1.54	0	0.21
<b>Alcohol</b>						
Yes			1			1
No	0.26	0.001	1.29	-1.6	0.002	0.2
<b>Personal history</b>						
Yes			1			1
No	-0.52	0.002	0.59	-1.1	0.007	0.33
<b>Family history</b>						
Yes			1			1
No	-2.69	0	0.067	-1.33	0.009	0.26
<b>Quality of life</b>						
Good			1			1
Bad	3.28	0	26.5	2.29	0	9.87
<b>AP Leisure</b>						
Good			1			1
Bad	0.26	0	1.3	0.671	0.04	1.9
<b>Healthy food</b>						
Good			1			1
Bad	0.89	0	2.4	0.56	0	1.7

Compared to tobacco, there is almost equal chance of non-smoking employees to have metabolic syndrome compared to smokers ( $p=0.005$ ,  $OR=1.23$ ). Also, for alcohol consumption, there is also almost equal chance of employees who consume alcohol to have metabolic syndrome compared to those who do not ( $p=0.002$ ,  $OR=1.29$ ). For a personal history of hypertension, CVD and / or T2DM, there is a 41% lower chance that those without a personal history of hypertension, CVD and T2DM have metabolic syndrome compared to those who have some ( $p=0.002$ ,  $OR=0.59$ ). As for a family history of hypertension, CVD and / or T2DM, there is almost 99% less chance for employees who do not have a family history of hypertension, CVD and T2DM developing the metabolic syndrome compared to those who have a family history of hypertension, CVD and / or T2DM ( $p=0.000$ ,  $OR=0.01$ ).

In relation to quality of life, there is a 26 times greater chance that employees of SNEL in Kinshasa who have a poor quality of life of developing the metabolic syndrome compared to those who have a good quality of life ( $p=0.000$ ,  $OR=26.5$ ). Compared to recreational physical activity, there is almost equal chance that employees who do not practice recreational physical activity develop metabolic syndrome compared to those who do ( $p=0.000$ ,  $OR=1.3$ ). Finally, when it comes to healthy eating, employees who have poor diet are twice as likely to have metabolic syndrome compared to those who have a good diet ( $p=0.000$ ,  $OR=2.4$ ). After the intervention, it emerges from the same table that the risk factors associated with the metabolic syndrome in SNEL employees are: age, level of education, Functions, sedentary lifestyle, Tobacco, Alcohol, personal and family history of 'HTA, MCV and / or T2D, Quality of life, food and APL.

Indeed, with regard to age, there is 3 times more chance that agents who are 40 years of age and over to develop the metabolic syndrome compared to those who are less than 40 years ( $p=0.009$ ,  $OR=3.09$ ). In terms of education level, there is a 52% lower chance that employees with low education levels will develop metabolic syndrome compared to those with low education ( $p=0.008$ ,  $OR=0.48$ ). For function, there is 36% less chance than SNEL employees who are non-bureaucrats to have metabolic syndrome compared to bureaucratic employees ( $p=0.001$ ,  $OR=0.64$ ). Compared to a sedentary lifestyle, there is a 55.5% lower chance for employees who are not sedentary to develop metabolic syndrome compared to those who are sedentary ( $p=0.008$ ,  $OR=0.445$ ). Compared to tobacco, there is a 79% lower chance of non-smoking employees of having metabolic syndrome compared to smokers ( $p=0.000$ ,  $OR=0.21$ ).

Also, for alcohol consumption, employees who do not consume alcohol are 80% less likely to have metabolic syndrome compared to those who consume it ( $p=0.002$ ,  $OR=0.20$ ). For a personal history of hypertension, CVD and / or T2DM, there is a 67% lower chance that those without a personal history of hypertension, CVD and / or T2D have metabolic syndrome compared to those which have ( $p=0.007$ ,  $OR=0.33$ ). As for a family history of hypertension,

CVD and / or T2DM, there is almost less than 76% chance for employees who do not have a family history of hypertension, CVD and / or T2DM developing the metabolic syndrome compared to those with a family history of hypertension, CVD and / or T2DM ( $p=0.009$ ,  $OR=0.26$ ).

In relation to the quality of life, there is 10 times more chance that employees of SNEL in Kinshasa who have a poor quality of life to develop the metabolic syndrome compared to those who have the good quality of life ( $p=0.000$ ,  $OR=9.87$ ). For recreational physical activity, employees who do not engage in recreational physical activity are twice as likely to develop metabolic syndrome compared to those who do ( $p=0.000$ ,  $OR=1.9$ ). Finally, when it comes to healthy eating, employees who have poor diet are twice as likely to have metabolic syndrome compared to those who have a good diet ( $p=0.000$ ,  $OR=1.7$ ).

### Discussion

The prevalence of metabolic syndrome depends on the definition used, the year of the study, the ethnicity, the age and the sex of the population, which does not make analyzes between countries and between continents very objective [38-40]. As reported by the literature review, regardless of the definition used, the presence of Smet in a population really shows that MCR, a precursor of CVD and T2DM, is present and this calls for action. The results of the majority of epidemiological studies on MCR carried out in the clinic, in the general population or in the workplace, have reported an African population characterized not only by the presence of Smet, a high risk of developing NCDs, many factors of cardiovascular risk but also the presence of already confirmed diseases, mainly T2DM, CVD or even chronic kidney disease [6,41-43]. It therefore seemed imperative to act sooner and detect this MCR in the SNEL workplace, at the very beginning of its development. Especially since during screening campaigns, both in PDs and DCs, the most alarming is that most people are unaware of their state of health [44]. This situation is a challenge for the health system.

Thus, in the present study, the metabolic syndrome was assessed according to the criteria of the new approach as detailed in the methodology. It considered the same parameters as the FID 2009 (abdominal obesity according to local thresholds, dysglycemia, dyslipidemia and high blood pressure) while having, however, rectified certain criteria, in particular the thresholds for abdominal obesity. ( $\geq 94$  cm for both sexes according to local thresholds specific to DR Congo), high blood pressure or pre-hypertension according to WHO [45] ( $PAS \geq 120$  mmHg and  $PAD \geq 80$  mmHg) and dyslipidemia (for a total cholesterol level  $\geq 5.2$  mmol/L). It should be noted that the study by Nasila Sungwasha et al has consolidated the choice of the Smet approach as defined in this thesis. Indeed, they concluded in their study that the constellation of non-lipid variables is sufficient to define MCR in black Africans including carbohydrate metabolism,

blood pressure and obesity. They also noted that three factors among dyslipidemia, abdominal hypertension, and obesity, and dysglycemia are identified in the Smet phenotype in African Bantus.

And obviously, the waistlines should be defined according to the thresholds specific to the African Bantu [46]. The results of this study reported alarming rates of Smet and FRCV and behavioral RF determining not only the emergence of MCV but also the danger of the early onset of CVD and T2DM and socio-professional and disabling consequences, in particular in terms of quality of life and productivity [47]. Worse, most participants in this study were unaware of their risk profile. The results of this study showed that the rate of Smet was significantly associated with age in the 41-50 age group, however the highest rate was concentrated in the 51-60 age group (the mean age of this study population was  $51.6 \pm 7.5$  years). These results are consistent with those from the NHANES survey, the D.E.S.I.R study and the MONICA study, which determined that Smet was associated with aging [48,49], and its frequency increased with age. And the WHO has announced an improvement in life expectancy in SSA countries, particularly in the WHO African region where it increased by 9.5 years from 2010 to 2015, or 60 years [47,50].

Apart from the fact that older people are sedentary, this advancement in age increases the risk burden associated with non-communicable and chronic diseases. The study by Ouédraogo et al, carried out on a population in the workplace of Burkina Faso with a sex ratio equal to 2.7 as in the present study, clearly illustrated the association of Smet with age. Although the average age was far lower than that of this study, i.e.  $42.07 \pm 9.3$  years, the highest rate of Smet was the most represented in the 40-60 age group [51]. According to WHO, the prevalence of sedentary lifestyle in SSA varies depending on the country from 6.5% to 51% with a median of 24%. Sedentary lifestyle contributes to the development of metabolic syndrome through obesity. The results of this study reveal a working population with one of the highest sedentary rates in SSA. Studies conducted in other workplaces have also reported high rates of sedentary lifestyle such as those conducted in Morocco [52] and Senegal [53]. Sedentary lifestyle contributes to the development of metabolic syndrome through obesity. Since 2005, lack of physical activity has been recognized as an emerging occupational risk factor by the European Agency for Safety and Health at Work [54].

It is worth remembering that the usual level of physical activity is now recognized as one of the important determinants of health status. The volume of PA recommended by WHO for achieving health impact has evolved into seeking every opportunity to be active in all circumstances of life. In agreement with Goldberg and Zins, who state that recreational PA is a protective factor for cardiovascular risk, this study found that there is twice as much chance that agents who do not engage in physical activity leisure activities of developing metabolic syndrome compared to those

who practice it [55]. Few studies have reported the association between Smet and quality of life. Conversely, this study reports that SNEL agents which have a low quality of life have a 10 times greater chance of developing the metabolic syndrome compared to those which have a high quality of life.

Unlike the study by Vetter and Wadden which failed to establish significant relationships between these two parameters [56]. In addition, an Australian study has shown that an employee in poor health has on average 18 days of absence compared to 2 days for an employee in good health (Guide to promoting health and wellness in the workplace, 2012). Many studies have shown that physical activity reduces the rate of sick leave. For example, according to the WHO, physical activity programs in the workplace can reduce sick leave by 6% to 32%, and therefore absenteeism on the employer side [57]. Numerous studies have demonstrated the benefits of physical activity in the workplace on indicators of well-being and quality of life at work: employee morale, self-confidence, job satisfaction, cohesion between teams, stress level [58,59]. In 2015, a first study carried out by Goodwill management with more than 200 companies, carried out by Medef with the French National Olympic and Sports Committee, showed that sports activity improved the quality of life at work.

The benefits for the employer were reduced absenteeism, lower accidents at work and improved performance [60]. Finally, when it comes to healthy eating, agents who have poor diet are twice as likely to have metabolic syndrome compared to those who have a good diet. Trend studies carried out in several countries illustrate unhealthy diet (having lost food quality) [61,62] and its consequences for human health [63,64]. This loss of quality is expressed by the tendency to replace a diversified diet rich in fruits, vegetables, fiber, and whole grains in favor of red meats, cold meats, and ready-to-eat food products [64,65]. According to the most recent data from the Global Burden of Disease, Injuries, and Risk Factor study 2013 (GBD 2013), the risk associated with unhealthy or poor-quality food is the leading cause of death worldwide with 11.3 million deaths in 2013 ahead of tobacco, alcohol and physical inactivity combined. The greatest risks have been associated with a diet low in vegetables, whole grains, fruits, fiber and high in sodium [66].

### Conclusion

The present study described a working population characterized by an epidemic rate of Metabolic Syndrome (46.7%) which was lowered by management based on moderate individual PA and healthy diet and improvement of quality of life. It determined the RF associated with Smet such, age  $\geq 40$  years, level of university studies, bureaucratic function, sedentary lifestyle, tobacco, excessive alcohol consumption, family history of hypertension and cardiovascular disease. In addition, she also determined protective factors which are good quality of life, healthy diet, and regular and moderate leisure PA. These results call for the urgent implementation of targeted preventive and

therapeutic strategies for the metabolic syndrome to combat the emergence of chronic and non-communicable diseases.

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### Author's Contribution

LKKK and ANN designed and analyzed the statistical data for the study. SK and HATK contributed to the data collection. BLM supervised the study. All authors have read and approved the final and revised version of the manuscript.

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