Effects of Lifestyle Changes on Dyslipidemia in Patients with Metabolic Syndrome in Kisangani City, Democratic Republic of Congo.

Tshitenge Babanya Kabudi Willy[1], Batina Agasa Salomon[1], Atoba Bokele Camille[1], Mbo Mukonkole Jean-Paulin[1], Kambale Kombi Paul[1], Losimba Likwela Joris[2], Kayembe Tshilumba Charles[1]

1. Department of Internal Medicine, Faculty of Medicine and Pharmacy, University of Kisangani, DRC.
2. Department of Public Health, Faculty of Medicine and Pharmacy, University of Kisangani, DRC

Citez cet article: Tshitenge B.K.W, Batina A.S, Atoba B.C., Mbo M.J-P., Kambale K.P., Losimba L.J., Kayembe T.C. Effects of Lifestyle Changes on Dyslipidemia in Patients with Metabolic Syndrome in Kisangani city, Democratic Republic of Congo. *KisMed* Mars 2025, Vol 14(1): 680-691

RESUME

Introduction : Le but de cette étude est d'évaluer l'efficacité de l'activité physique combinée à l'arrêt du grignotage sur la dyslipidémie chez les patients atteints du syndrome métabolique. **Méthodes** : 69 participants âgés de 18 ans et plus, atteints du syndrome métabolique et ayant visité les "Cliniques Universitaires de Kisangani" en République Démocratique du Congo ont été inclus dans cette étude quasi-expérimentale. Ils ont été divisés en deux groupes : le groupe d'intervention (43 participants) a pratiqué 180 minutes de marche par semaine et s'est abstenu de grignoter entre les repas, tandis que le groupe de contrôle (26 participants) n'a pas effectué ces changements. Les taux sanguins de cholestérol HDL et de triglycérides ont été mesurés au départ, trois mois et neuf mois après l'intervention. Une analyse de régression multivariée a été réalisée pour identifier les facteurs de risque associés à la dyslipidémie, en mettant l'accent sur les différences entre les groupes et en fonction du temps. **Résultats :** Après neuf mois, le groupe d'intervention a montré des améliorations significatives des niveaux de cholestérol HDL et de triglycérides par rapport au groupe de contrôle ($p < 0,05$). L'intervention était notamment associée à une augmentation du cholestérol HDL après trois mois (AOR = 0,03 ; $p < 0,05$) et neuf mois (AOR = 0,03 ; $p < 0,05$). Le sexe masculin était significativement lié à cette amélioration au bout de 9 mois (AOR = 0,11 ; $p < 0,05$). En outre, après neuf mois, l'intervention était significativement associée à des améliorations des niveaux de triglycérides (AOR = 0,17 ; $p < 0,05$). **Conclusion** : Les résultats indiquent que neuf mois de marche régulière et d'abstention de grignotage peuvent améliorer les taux plasmatiques de cholestérol HDL et de triglycérides. Après neuf mois, cette intervention sur le mode de vie semble protéger contre le faible taux de cholestérol HDL et l'hypertriglycéridémie.

Mots clés : *mode de vie, dyslipidémie, syndrome métabolique, quasi-expérimental, grignotage.*

SUMMARY

assess the efficacy of a combination of physical activity and the cessation of snacking on dyslipidemia in patients diagnosed with metabolic syndrome. **Methods**. This quasi-experimental study was conducted with a sample of 69 participants aged 18 years and older who were diagnosed with metabolic syndrome and visited the "Cliniques Universitaires de Kisangani" in the Democratic Republic of Congo. The participants were divided into two groups: the intervention group (43 participants) engaged in 180 minutes of walking per week and abstained from snacking between meals, while the control group (26 participants) did not implement these modifications. The study measured the blood levels of HDL cholesterol and triglycerides at three time points: at the beginning of the study, three months after the intervention, and nine months after the intervention. A multivariate regression analysis was performed to identify risk factors associated with dyslipidemia, focusing on differences between groups and over time. **Results:** After a period of nine months, the intervention group exhibited significant enhancements in HDL cholesterol and triglyceride levels in comparison to the control group ($p < 0.05$). The intervention was found to be particularly associated with an increase in HDL cholesterol after three months (AOR = 0.03; $p < 0.05$) and nine months (AOR = 0.03; $p < 0.05$). The male gender was found to be significantly associated with this improvement at 9 months (AOR = 0.11; $p < 0.05$). Furthermore, after a period of nine months, the intervention demonstrated a significant association with improvements in triglyceride levels (AOR = 0.17; $p < 0.05$). **Conclusion:** The findings indicate that nine months of regular walking and abstaining from snacking can improve plasma HDL cholesterol and triglyceride levels. After nine months, this lifestyle intervention appears to protect against low HDL cholesterol and hypertriglyceridemia.

Keywords: *lifestyle, dyslipidemia, metabolic syndrome, quasi-experimental, snacking*

Reçu : 08 Septembre 2024
Accepté: 20 Février 2025
Publié : 21 Mars 2025

Correspondance: *Tshitenge W., Department of Internal Medicine, Faculty of Medicine and Pharmacy, University of Kisangani.*
Email: willybabanya1@gmail.com

INTRODUCTION

Metabolic syndrome (MetS) is a significant global public health issue characterized by a combination of metabolic disorders, including abnormalities in glucose, lipoproteins, insulin action, hypertension, and central obesity [1]. It is particularly problematic in sub-Saharan Africa and the Democratic Republic of Congo (DRC) [2,3], where the prevalence is reported to be 29.1% in Kisangani [4], with hypertriglyceridemia affecting 46.3% and low HDL cholesterol at 10.4% [4].

Both metabolic syndrome and its components are linked to a higher incidence of atherosclerotic cardiovascular disease [5]. Consequently, lifestyle modifications incorporating regular physical activity and a healthy diet are recognized as first-line interventions for preventing and managing insulin resistance, hyperglycemia, hypertension, and dyslipidemia [6].

Dyslipidemia is a metabolic disorder resulting from elevated cholesterol (C) and triglycerides (TG) in the blood. It is characterized by high levels of low-density lipoprotein cholesterol (LDL-C), often accompanied by low levels of high-density lipoprotein cholesterol (HDL-C) and elevated TG levels, primarily in the form of triglyceride-rich lipoproteins (TRL) like chylomicrons and very low-density lipoproteins (VLDL) [7]. Dyslipidemia is a significant cardiovascular risk factor [8], and thus, reducing LDL-C and TRL levels is a key objective in preventing and treating cardiovascular disease (CVD) [9].

Adopting a healthy diet and engaging in physical activity are essential for lowering LDL-C and TG levels [9]. Depending on the severity of dyslipidemia and overall CVD risk, additional pharmacological treatments may be necessary. Nonetheless, appropriate dietary and lifestyle changes can prevent approximately 80% of premature CVD mortality [10,11,12]. Physical activity has been associated with better cholesterol profiles and reduced blood triglyceride levels [13,14,15].

Various dietary approaches, including Mediterranean-style diets, the DASH (Dietary Approaches to Stop Hypertension) diet, and other restrictive diets, effectively reduce cardiovascular risk factors, including LDL-C levels, and lower the overall risk of cardiovascular disease [16,17]. Mediterranean-style diet is rich in whole grain cereals, fruits, vegetables, nuts, and olive oil whereas DASH is rich in fruits, vegetables, and low-fat dairy food [18].

Restrictive diets include intermittent fasting, time-restricted eating, fasting mimicking diets and calorie-restricted diets that may be low in fat and/or carbohydrates [16].

Among restrictive diets, time-restricted eating—specifically reducing the frequency of meals consumed away from home has been evaluated [14,16]. Meals eaten away from home have been linked to hypertriglyceridemia, central obesity, hyperglycemia, and hypertension, particularly in men [14]. Interventions involving restrictive diets have shown improvements in insulin sensitivity and metabolic profiles compared to control groups [16].

However, limited research has focused on eliminating snacking as a form of restrictive dieting to MetS and its components [19].

In the DRC context, the primary meal is often consumed away from home, making it impractical to recommend reducing or eliminating such meals. Instead, targeting snacking is a viable option. When medications and specialized diets are costly, promoting physical activity and minimizing snacking can be effective, low-cost strategies. The concept of exercise dosage, including intensity, frequency, and duration, is still under investigation [20]. Nonetheless, the World Health Organization (WHO) recommends that adults engage in at least 150 to 300 minutes of moderate-intensity weekly aerobic activity [21].

This study evaluates the effects of a lifestyle intervention that combines

walking with the avoidance or elimination of snacking on dyslipidemia in individuals with metabolic syndrome.

METHODS

This quasi-experimental study was conducted at the "Cliniques Univesitaires de Kisangani" from 1st June 2020 to 30th November 2022. Measurements were taken from experimental and non-equivalent comparison groups before and after the intervention.

To assess the impact of lifestyle changes on the components of metabolic syndrome in diagnosed individuals, we conducted a sample size calculation using power analysis for a logistic regression test with G*Power (version 3.1.9.4, Institute for Experimental Psychology, Heinrich Heine University Düsseldorf, Germany) [22]. With a desire magnitude of effect set at 2.7, a significance level (α) set at 0.05 and a power (1 - β) set at 0.8 to detect statistically significant differences between the intervention and control groups. Our calculations indicate that a total of 62 participants are needed. To account for an estimated dropout rate of 10%, we adjusted the sample size, resulting in a minimum requirement of approximately 69 participants. This will enable us to effectively evaluate the impact of lifestyle interventions on metabolic health in individuals with metabolic syndrome.

Participants included individuals aged 18 and older who had been diagnosed with MetS and had provided informed consent to participate. Those excluded from the study had exertional dyspnea, a decubitus cough, lower limb oedema, known heart failure, chronic renal failure, or were on corticosteroids or oral contraceptives. Type 1 diabetics and individuals who declined participation were also excluded. Ultimately, 69 individuals were selected.

Participants received thorough information regarding the study's objectives, procedures, potential benefits, risks, and the option to be part of a non-intervention group. They were divided into experimental and control groups. The experimental group (43 participants) consisted of individuals who agreed to stop snacking and walk according to a defined schedule. The frequency and duration of walking were flexible based on individual availability. The control group (26 participants) included individuals who did not agree to stop snacking or were unwilling or unable to walk due to contraindications.

Intervention Details

1. Walking for a total of 180 minutes per week:
- 60 minutes per day on any three days of the week:
- One 60-minute session per day
- Two 30-minute sessions each day (morning and evening)
- 90 minutes per day for any two days of the week:
- One 90-minute session per day
- Two 45-minute sessions each day (morning and evening)

2. Stop Snacking: Participants were instructed to refrain from eating (except for fruits and vegetables) or drinking (other than water) outside of main meals, whether at home or elsewhere.

Motivated supervisors monitored Compliance with intervention protocols regularly without the participants' knowledge. In addition to collecting anthropometric data, blood pressure measurements, waist circumference, fasting blood glucose, triglycerides, and HDL cholesterol were taken in both groups before and after the intervention. After the first four weeks, participants were assessed for their difficulties adhering to the walking and snacking guidelines. Follow-up assessments occurred at 12 and 36 weeks. The definition of metabolic syndrome followed the criteria set by the National Cholesterol Education Program Adult Treatment Panel 3 (NCEP ATP 3, 2005) [23]. A focus on vegetables, legumes, fruits, whole grains, skinless poultry, fish, shrimp, and low-fat dairy products characterized the low-fat diet (LFD) [24-25].

Statistical Analysis

Categorical variables were described using counts and proportions, supplemented by bar charts. Chi-square or Fisher's exact tests were employed for bivariate analysis based on applicable conditions. Factors

associated with dyslipidemia were identified through multivariate analysis using logistic regression. All statistical analyses were conducted using SPSS software (version 22.0). A confidence interval of 95% was established, with a p-value of less than 0.05 considered statistically significant.

Ethical considerations

The protocol for this study was approved by the research ethics committee of the University of Kisangani (Approval number: UNIKIS/CER/007/2018).

RESULTS

Figure 1 shows the participant recruitment. The total number of participants in this study was 163. Of these, 88 individuals were excluded due to various factors mostly for non-consenting. Of the 75 remaining individuals, 49 were assigned to the intervention group and 26 to the control group. 6 participants in the experimental group dropped out before the end of the intervention period (9 months), leaving 43 participants at the end of the study. Finally, only 69 individuals participated in this study.

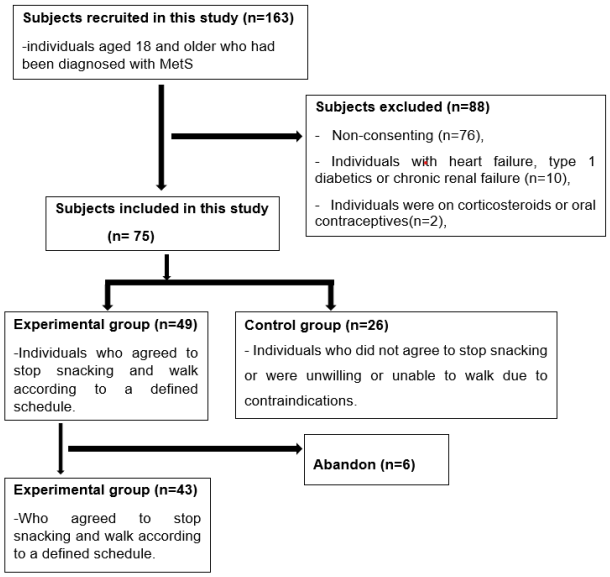

Figure1: Participant recruitment

Table 1 presents the baseline characteristics of participants categorized by low HDL cholesterol and hypertriglyceridemia (HTG). At baseline, no statistically significant differences existed between individuals with low HDL cholesterol and those with normal HDL levels regarding sex, age, intervention, or adherence to a low-fat diet ($p > 0.05$). Similarly, no significant differences were found between participants with hypertriglyceridemia and those with normal triglyceride levels. The study included 69 participants, comprising 41 men (59.4%) and 28 women (40.6%).

Table 1 Baseline characteristics of participants according to low HDL-cholesterol and hypertriglyceridemia (N=69)

Figure 2 compares subjects with low HDL cholesterol and those with normal HDL cholesterol levels before and after 3 and 9 months of intervention. In Figure 2A, 13 out of 43 participants in the experimental group had low HDL cholesterol before the intervention, compared to 11 out of 26 in the control group. After three months of intervention (Figure 2B), only 1 participant in the experimental group continued to have low HDL cholesterol, which remained the same after nine months (Figure 2C).

Statistical analysis revealed a significant difference between subjects with low HDL cholesterol and those with normal levels following the intervention at both three months and nine months ($p < 0.001$) (Figures 2B and 2C).

Figure 3 illustrates the comparison between subjects with hypertriglyceridemia and those with normal plasma triglyceride levels before and after 3 and 9 months of intervention. At baseline, 25 out of 43 participants in the experimental group had hypertriglyceridemia, compared to 13 out of 26 in the control group (Figure 3A). After three months of intervention (Figure 3B), the number of participants with hypertriglyceridemia in the experimental group decreased to 13, and this further declined to just five after nine months (Figure 3C).

Following the intervention, a statistically significant difference was observed between subjects with hypertriglyceridemia and those with normal plasma triglyceride levels after nine months.

Table 2 examines the factors linked to improved plasma HDL-cholesterol levels at 3- and 9-months post-intervention.

positively associated with changes in plasma HDL-C levels.

Table 1 *Baseline characteristics of participants according to low HDL-cholesterol and hypertriglyceridemia (n=69)*

Characteristic	Low HDL-cholesterol					Hypertriglyceridemia				
	Yes		No		P	Yes		No		P
	n	%	n	%	value	n	%	n	%	value
Sex										
M	14	58.3	27	60	0.89	23	60.5	18	58	0.84
F*	10	41.7	18	40		15	39.5	13	42	
Age (Years)										
< 40*	4	16.7	12	26.7		10	26.3	6	19.3	
40-55	14	58.3	21	46.6	0.57	21	55.3	14	45.2	0.27
> 55	6	25	12	26.7		7	18.4	11	35.5	
Intervention										
Yes	18	75	25	55.6	0.11	24	63.2	19	61.3	0.87
No	6	25	20	44.4		14	36.8	12	38.7	
LFD										
Yes	11	45.8	16	35.6	0.40	14	36.8	13	42	0.67
No	13	54.2	29	64.4		24	63.2	18	58	
Total	24	100	45	100		38	100	31	100	

* Reference modality, LFD: Low-fat diet.

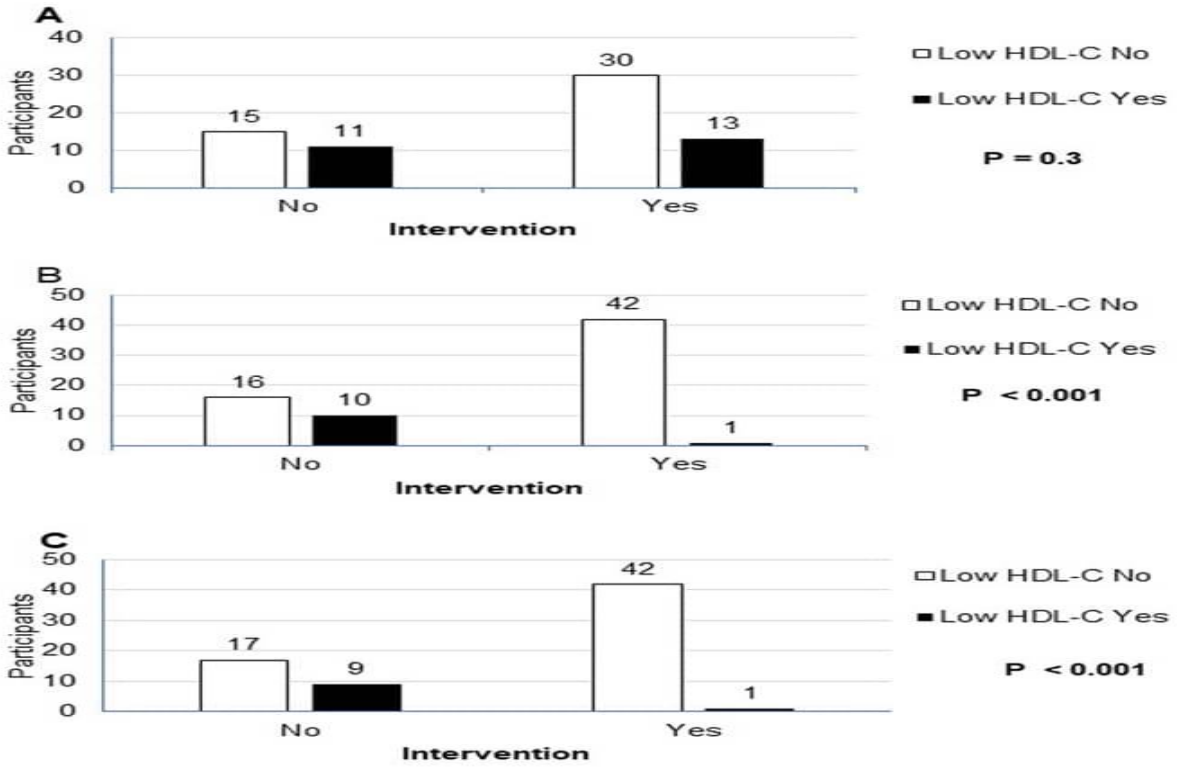

Figure 2 Comparison of subjects with low HDL-cholesterol at baseline(A), three months after intervention(B), and nine months after intervention(C).

The intervention was associated with enhanced plasma HDL-C levels after three months, as shown in the bivariate analysis (p = 0.003). This finding was further supported by multivariate analysis, which revealed that the intervention (AOR = 0.03, 95% CI 0.00 to 0.21, p = 0.003) was

After nine months, male sex and the intervention were significantly associated with improved plasma HDL-cholesterol levels in the bivariate analysis (p = 0.014 and p = 0.005, respectively). In the multivariate analysis, the male sex (AOR = 0.11, 95% CI 0.01 to 0.61, p = 0.020) and

the intervention (AOR = 0.03, 95% CI 0.00 to 0.24, p = 0.005) were both positively associated with changes in plasma HDL-C levels.

Table 3 examines the factors related to improved plasma triglyceride levels at 3- and 9-months post-intervention. After three months, no factors were associated with changes in plasma triglyceride levels in the bivariate or multivariate analysis.

However, at nine months, the intervention demonstrated a significant association with improved plasma triglyceride levels in both the bivariate analysis (p = 0.012) and the multivariate analysis (AOR = 0.17, 95% CI 0.04-0.64, p = 0.012).

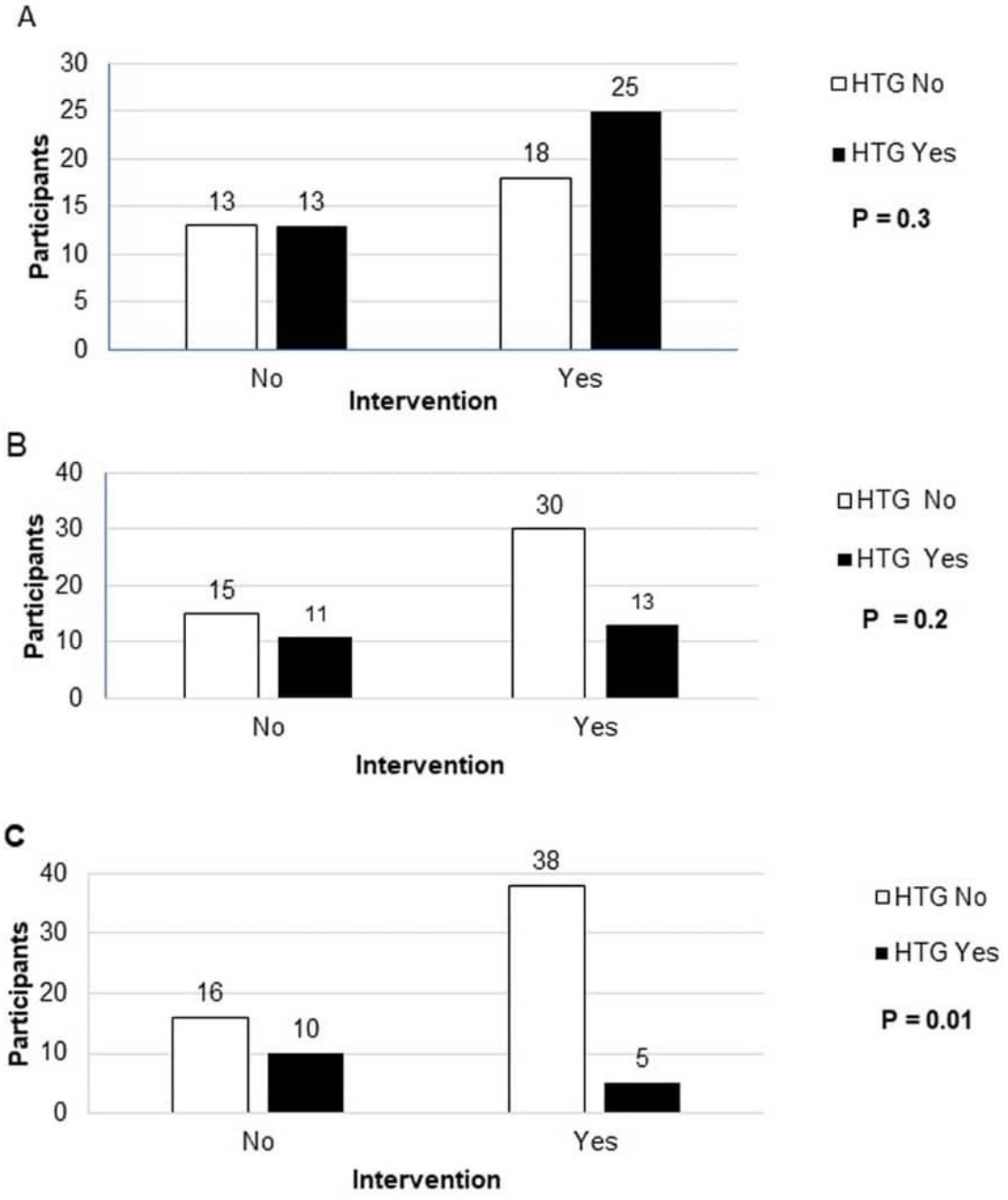

Figure 3 Comparison of subjects with hypertriglyceridemia at baseline(A), three months after intervention(B), nine months after intervention(C).

the intervention was the only factor positively linked to changes in plasma HDL

Table 2 shows factors associated with improved plasma HDL-cholesterol levels at 3- and 9-months post-intervention.

Factors	Low HDL-cholesterol							
	3 months later							
	Yes		No		OR (95% CI)	P-Value	AOR (95% CI)	P-value
	n	%	n	%				
Sex								
M	4	9.8	37	90.2	0.32(0.80-1.20)	0.10	0.35(0.06-1.71)	0.2
F*	7	25	21	75				
Age (years)								
< 40*	1	33.3	2	66.7	-	-	-	-
40-55	7	14.6	41	85,4	0.34(0.03-7.92)	0.4	0.22(0.01-8.89)	0.4
> 55	3	16.7	15	83.3	0.40(0.03-10.2)	0.5	0.26(0.00-11.1)	0.5
Intervention								
Yes	1	2.3	42	97.3	0.04(0.00-0.22)	0.003	0.03(0.00-0.21)	0.003
No	10	38.5	16	61.5				
LFD								
Yes	6	22.2	21	77.8	2.11(0.57-8.16)	0.3	2.71(0.47-19.2)	0.3
No	5	11.9	37	88.1				
Total	11	15.9	58	84.1				
	9 months later							
	Yes		No		OR (95% CI)	P-value	AOR (95% CI)	P-Value
	n	%	n	%				
Sex								
M	2	4.9	39	95.1	0.13(0.02-0.57)	0.014	0.11(0.01-0.61)	0.020
F*	8	28.6	20	71.3				
Age (years)								
< 40*	1	33.3	2	66.7	-	-	-	-
40-55	6	12.5	42	87.5	0.29(0.02-6.69)	0.3	0.29(0.01-12.3)	0.7
> 55	3	16.7	15	83.3	0.40(0.03-10.2)	0.5	0.44(0.04-19.6)	0.5
Intervention								
Yes	1	2.3	42	97.7	0.04(0.00-0.27)	0.005	0.03(0.00-0.24)	0.005
No	9	34.6	17	65.4				
LFD								
Yes	5	18.5	22	81.5	1.68(0.42-6.69)	0.4	2.28(0.31-20.4)	0.4
No	5	11.9	37	88.1				
Total	10	14.5	59	85.5				

DISCUSSION

In our study, HDL-cholesterol levels showed significant improvement after 3 and 9 months in the experimental group compared to the control group ($p<0.05$). Conversely, hypertriglyceridemia improved significantly only after nine months of intervention in the experimental group relative to the control group ($p<0.05$). There was also an enhancement in the lipid profile within the control group. Specifically, of the 11 subjects with low HDL cholesterol at baseline, 2 showed improved HDL levels after nine months. Similarly, among the 13 subjects with hypertriglyceridemia at baseline, three had improved their triglyceride levels after nine months of intervention.

Regarding factors associated with lipid profile improvement, after three months, levels (AOR = 0.03, 95% CI 0.00 to 0.21, p = 0.003). After nine months, both male sex (AOR=0.11, 95% CI 0.01 to 0.61, p = 0.020) and the intervention (AOR= 0.03, 95% CI 0.00 to 0.24, p = 0.005) were positively associated with changes in plasma HDL-C levels. The intervention appears to act as a protective factor (AOR < 1), reducing the risk of low HDL-C by 0.03 after 3 and 9 months. Male sex also showed a protective effect (AOR < 1), reducing the risk of low HDL-C by 0.11 after nine months. At this time point, the intervention was the only factor positively linked to changes in plasma triglyceride levels (AOR = 0.17, 95% CI 0.04 to 0.64, p = 0.012), serving as a protective factor (AOR < 1), decreasing the risk of hypertriglyceridemia by 0.17.

Our findings align with several previous studies. Mahadzir et al. in Malaysia reported a reduction in blood triglyceride levels and an increase in plasma HDL-cholesterol after six months of a healthy lifestyle as part of the PERSUADE program [26]. A study in Turkey indicated significant improvement in lipid profiles in the experimental group following 12 weeks of lifestyle intervention [27]. Wang et al. observed notable improvements in lipid profiles (HDL-C and triglycerides) after eight weeks of aerobic exercise among subjects with coronary artery disease [14]. A systematic review and meta-analysis demonstrated that physical activity interventions and a healthy diet in individuals with metabolic syndrome led to enhanced HDL-C levels but no decrease in triglycerides [28]. The duration of interventions varies across studies, with our study showing plasma triglyceride levels improving after 36 weeks. In contrast, findings from Chaiyasoot et al., [29] which involved a 12-week lifestyle change program in obese Thai adults with metabolic syndrome, indicated no significant improvements in HDL cholesterol or triglycerides. This discrepancy may stem from the fact that all subjects in the Thai study were obese, whereas our study included a more diverse population. Additionally, while our research focused on snacking suppression, the calorie intake and composition of main meals were not monitored, unlike in the study by Chaiyasoot et al [29].

The literature supports the benefits of physical activity and a healthy diet in increasing HDL-cholesterol and decreasing triglyceride levels [14,26,30-34]. Diets low in ultra-processed foods, sugars, and dried seeds have been shown to lower blood glucose, blood pressure, and triglycerides while increasing HDL-C [31]. Physical activity enhances insulin secretion, promoting triglyceride storage in the liver and muscle oxidation, which contributes to lower circulating triglyceride levels [32].

Table 3 factors associated with improved blood triglyceride levels at 3- and 9-months post-intervention.

Factors	**Low HDL-cholesterol**							
	3 months later							
	Yes		No		OR (95% CI)	P-Value	AOR (95% CI)	P-value
	n	%	n	%				
Sex								
M	15	36.6	26	63.4	1.22(0.44-3.45)	0.7	1.53(0.50-5.01)	0.5
F*	9	32.1	19	67.9				
Age (years)								
< 40*	2	31.2	1	68.8	-	-	-	-
40-55	13	40	35	60	0.19(0.01-2.10)	0.2	0.12(0.00-1.58)	0.12
> 55	9	27.8	9	72.2	0.50(0.02-6.16)	0.6	0.37(0.01-5.30)	0.5
Intervention								
Yes								
No	13	30.2	30	69.8	0.59(0.21-1.64)	0.3	0.64(0.21-1.88)	0.4
LFD	11	42.3	15	57.7				
Yes								
No	11	40.7	16	59.3	1.53(0.56-4.24)	0.4	2.11(0.70-6.73)	0.2
Total	11	15.9	58	84.1				
	9 months later							
	Yes		No		OR (95% CI)	P-value	AOR (95% CI)	P-Value
	n	%	n	%				
Sex								
M	11	26.8	30	73.2	2.20(0.66-8.74)	0.2	3.72(0.86-20.8)	0.10
F*	4	14.3	24	85.7				
Age (years)								
< 40*	1	33.3	2	66.7	-	-	-	-
40-55	7	14.6	41	85.4	0.34(0.03-7.92)	0.4	0.10(0.00-2.98)	0.13
> 55	7	38.9	11	61.1	1.27(0.10-30.5)	0.9	0.41(0.02-12.6)	0.6
Intervention								
Yes	5	11.6	38	88.4	0.21(0.06-0.69)	0.012	0.17(0.04-0.64)	0.012
No	10	38.5	16	61.5				
LFD								
Yes	7	25.9	20	74.1	1.49(0.46-4.77)	0.5	2.48(0.63-10.8)	0.2
No	8	19.0	34	81.0				
Total	15	21.7	54	78.3				

Moreover, exercise activates enzymes crucial for lipid metabolism, reducing circulating triglycerides and raising HDL-C levels [33]. Elevated adiponectin levels during exercise also facilitate fat oxidation, reducing triglyceride levels [33]. Given that obesity contributes to both low HDL-C and hypertriglyceridemia and noting that women tend to be more obese and sedentary than men, physical activity becomes a key factor in increasing HDL-C levels [33-37]. Men are less likely than women to develop low HDL-C levels. The "Hawthorn effect" may also account for improvements in dyslipidemia observed in our study [38-39].

Strengths and Limitations

A significant strength of this study was its investigation of snacking suppression as a restrictive diet, particularly relevant in contexts where a single meal, often taken away from home, constitutes the main meal of the day. However, several limitations should be acknowledged. First, the individual contributions of lifestyle components (walking and snacking suppression) to the results were not assessed. Second, calorie intake and meal composition were not evaluated, nor were other lifestyle habits that could affect dyslipidemia (e.g., alcohol consumption, smoking, sleep duration) [39-42]. Third, due to the small sample size, few factors associated with dyslipidemia were tested. So, there's a risk of discarding other factors associated that could influence the intervention's outcome. Lastly, since the study focused solely on individuals with metabolic syndrome, the generalizability of the findings is limited to this population.

CONCLUSION

This preliminary study demonstrates that a healthy lifestyle, incorporating physical activity and no snacking, can effectively improve dyslipidemia, with earlier benefits for HDL-cholesterol compared to hypertriglyceridemia. Future cohort studies with appropriate randomization in the general population could validate these findings and support broader applicability.

ACKNOWLEDGMENTS

The authors thank Dr. Dieu Merci Bumba Lupaka and Dr. Gaspard Mande Bukaka for their statistical analysis contributions and Mr. Edouard Twakashikila Kasonga for translating this paper into English.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Willy Tshitenge Babanya Kabudi designed the study, developed the protocol, collected data, and wrote the manuscript. Salomon Batina Agasa contributed to the study design, protocol development, manuscript revision, and final drafting. Camille Atoba Bokele, Jean Paulin Mbo Mukonkole, Paul Kambale Kombi, and Joris Losimba Likwela participated in protocol development and manuscript revision. Charles Kayembe Tshilumba contributed to the study design, protocol development, and final manuscript drafting.

REFERENCES

1. Kassi E, Pervanidou P, Kaltsas G, Chrousos G. Metabolic syndrome: definitions and controversies. *BMC Med.* 2011; 9:48. doi:10.1186/1741-7015-9-48
2. Okafor CI. The metabolic syndrome in Africa: Current trends. *Indian J Endocrinol Metab.* 2012;16(1):56-66. doi:10.4103/2230-8210.91191
3. Katchunga PB, Hermans M, Bamuleke BA, Katoto PC, Kabinda JM. Relationship between waist circumference, visceral fat, and metabolic syndrome in a Congolese community: further research is still to be undertaken. *Pan Afr Med J.* 2013; 14: 20. Doi: 10.11604/pamj.14.20.1258
4. Tshitenge BKW, Bolukaoto BL, Kazadi MD, et al. Prévalence du syndrome métabolique chez l'adulte à Kisangani en République Démocratique du Congo. *KisMed* Juin 2023, Vol 13(2): 637-650
5. Owolabi EO, Goon DT, Adeniyi OV, Adedokun AO, Seiko E. Prevalence and Correlates of Metabolic Syndrome Among Adults Attending Healthcare Facilities in Eastern Cape, South Africa. *Open Public Health*

Journal.2017; 10(1): 148-159. doi:10.2174/1874944501710010148.
6. Kim HL, Chung J, Kim KJ, et al. Lifestyle Modification in the Management of Metabolic Syndrome: Statement from Korean Society of Cardio Metabolic Syndrome (KSCMS). *Korean Circ J*. 2022 Feb;52(2):93-109. doi: 10.4070/kcj.2021.0328
7. Ference BA, Ginsberg HN, Graham I, et al. Low-density lipoproteins cause atherosclerotic cardiovascular disease. 1. Evidence from genetic, epidemiologic, and clinical studies. A consensus statement from the European Atherosclerosis Society Consensus Panel. *European Heart Journal*. 2017; *38*(32), 2459–2472. doi.org/10.1093/eurheartj/ehx144
8. Hedayatnia M, Asadi Z, Zare-Feyzabadi R, et al. Dyslipidemia and cardiovascular disease risk among the MASHAD study population. *Lipids Health Dis*. 2020 March 16;19(1):42. doi:10.1186/s12944-020-01204-y
9. Mach F, Baigent C, Catapano AL, et al. 2019 ESC/EAS Guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk [published correction appears in Eur Heart J. 2020 November 21;41(44):4255]. *Eur Heart J*. 2020;41(1):111-188. doi:10.1093/eurheartj/ehz455
10. Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on Cardiovascular Disease Prevention in Clinical Practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J*. 2016;37(29):2315-2381. doi:10.1093/eurheartj/ehw106
11. Najafian J, Mohammadifard N, Naeini FF, Nouri F. Relation between usual daily walking time and metabolic syndrome. *Niger Med J*. Jan-Feb 2014; 55(1): 29–33. Doi: 10.4103/0300-1652.128156.
12. Zhou J, Wang Y, Lian F, et al. Physical exercises and weight loss in obese patients help to improve uric acid. *Oncotarget*. 2017;8(55):94893-94899. doi:10.18632/oncotarget.
13. Crichton GE, Alkerwi A. Physical activity, sedentary behavior time and lipid levels in the Observation of Cardiovascular Risk Factors in Luxembourg study. *Lipids Health Dis*. 2015; 14:87. doi:10.1186/s12944-015-0085-3
14. Wang H, Yu Y, Tian X. Does Eating-Away-from-Home Increase the Risk of a Metabolic Syndrome Diagnosis? *Int J Environ Res Public Health*. 2019;16(4):575. doi:10.3390/ijerph16040575
15. Kudo, N., Nishide, R., Mizutani, M. *et al.* Association between the type of physical activity and metabolic syndrome in middle-aged and older adult residents of a semi-mountainous area in Japan. *Environ Health Prev Med* 26, 46 (2021). doi: 10.1186/s12199-021-00949-x
16. Soliman GA. Intermittent fasting and time-restricted eating role in dietary interventions and precision nutrition. *Front Public Health*. 2022; 10:1017254. doi:10.3389/fpubh.2022.1017254
17. Zhang N, Xiao X, Xu J, et al. Dietary Approaches to Stop Hypertension (DASH) diet, Mediterranean diet and blood lipid profiles in less-developed ethnic minority regions. *Br J Nutr*. 2022;128(6):1137-1146. doi:10.1017/S0007114521004013
18. Hoyas I, Leon-Sanz M. Nutritional Challenges in Metabolic Syndrome. *J Clin Med*. 2019;8(9):1301. doi:10.3390/jcm8091301
19. Paoli A, Tinsley G, Bianco A, Moro T. The Influence of Meal Frequency and Timing on Health in Humans: The Role of Fasting. *Nutrients*. 2019;11(4):719. doi:10.3390/nu11040719
20. Vina J, Sanchis-Gomar F, Martinez-Bello V, Gomez-Cabrera MC. Exercise acts as a drug; the pharmacological benefits of exercise. *Br J Pharmacol*. 2012 Sep;167(1):1-12. doi: 10.1111/j.1476-5381.2012.01970.x
21. Bull FC, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behavior. *Br J Sports Med*. 2020;54(24):1451-1462. doi:10.1136/bjsports-2020-102955
22. Demidenko, E. (2007). Sample size determination for logistic regression revisited. *Statistics in Medicine*, *26*(18), 3385–3397. https://doi.org/10.1002/sim.2771

23. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*. 2009;120(16):1640-1645. doi:10.1161/CIRCULATIONAHA.109.192644
24. Bhandari P, Sapra A. Low Fat Diet. [Updated 2023 February 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK553097/.
25. Chopra AK. Dietary management of dyslipidemia. *Indian Heart J*. 2024 Mar; 76(Suppl 1): S65–S72. Doi: 10.1016/j.ihj.2023.12.005
26. Mahadzir MDA, Quek KF, Ramadas A. Nutrition and Lifestyle Behavior Peer Support Program for Adults with Metabolic Syndrome: Outcomes and Lessons Learned from a Feasibility Trial. *Nutrients*. 2020;12(4):1091. doi:10.3390/nu12041091
27. Aktas MF, Mähler Anja, Hamm M, Perger G et al. Lifestyle interventions in Muslim patients with metabolic syndrome-a feasibility study. *Eur J Clin Nutr*. 2019 May;73(5):805–808. doi: 10.1038/s41430-018-0371-z
28. Sequi-Dominguez I, Alvarez-Bueno C, Martinez-Vizcaino V, Fernandez-Rodriguez R, Del Saz Lara A, Cavero-Redondo I. Effectiveness of Mobile Health Interventions Promoting Physical Activity and Lifestyle Interventions to Reduce Cardiovascular Risk Among Individuals With Metabolic Syndrome: Systematic Review and Meta-Analysis. *J Med Internet Res*. 2020;22(8): e17790. doi:10.2196/17790
29. Chaiyasoot K, Sarasak R, Pheungruang B, et al. Evaluation of a 12-week lifestyle education intervention with or without partial meal replacement in Thai adults with obesity and metabolic syndrome: a randomized trial. *Nutr Diabetes*. 2018 Apr 25;8(1):23. doi: 10.1038/s41387-018-0034-0
30. Parhofer KG, Laufs U. The Diagnosis and Treatment of Hypertriglyceridemia. *Dtsch Arztebl Int*. 2019 Dec 6;116(49):825-832. doi: 10.3238/arztebl.2019.0825
31. Castro-Barquero S, Ruiz-León AM, Sierra-Pérez M, Estruch R, Casas R. Dietary Strategies for Metabolic Syndrome: A Comprehensive Review. *Nutrients*. 2020 Sep 29;12(10):2983. doi: 10.3390/nu12102983
32. Kirwan JP, Sacks J, Nieuwoudt S. The essential role of exercise in the management of type 2 diabetes. *Cleve Clin J Med*. 2017 Jul;84(7 Suppl 1): S15-S21. doi: 10.3949/ccjm.84.s1.03
33. Franczyk B, Gluba-Brzózka A, Ciałkowska-Rysz A, Ławiński J, Rysz J. The Impact of Aerobic Exercise on HDL Quantity and Quality: A Narrative Review. *Int J Mol Sci*. 2023 Feb 28;24(5):4653. doi: 10.3390/ijms24054653
34. Omar JS, Jaradat N, Qadoumi M, Qadoumi AN. Regular swimming exercise improves metabolic syndrome risk factors: a quasi-experimental study. *BMC Sports Sci Med Rehabil*. 2021 Mar 8;13(1):22. doi: 10.1186/s13102-021-00254-8
35. Stadler JT, Lackner S, Mörkl S, et al. Obesity Affects HDL Metabolism, Composition and Subclass Distribution. *Biomedicines*. 2021;9(3):242. doi:10.3390/biomedicines9030242
36. De Silva ST, Niriella MA, Ediriweera DS et al. Incidence and risk factors for metabolic syndrome among urban, adult Sri Lankans: a prospective, 7-year community cohort, follow-up study. *Diabetol Metab Syndr*. 2019; 11, 66. doi.org/10.1186/s13098-019-0461-7
37. Pallangyo P, Mkojera ZS, Hemed NR et al. The obesity epidemic in urban Tanzania: a public health calamity in an already overwhelmed and fragmented health system. *BMC Endocr Disord*. 2020;20(1):147. doi:10.1186/s12902-020-00631-3
38. Kassim MSA, Manaf MRA, Nor NSM, Ambak R. Effects of Lifestyle Intervention towards Obesity and Blood Pressure among Housewives in Klang Valley: A Quasi-Experimental Study. *Malays J Med Sci*. 2017 Dec;24(6):83-91. doi: 10.21315/mjms2017.24.6.10

39. Berkhout C, Berbra O, Favre J, et al. Defining and evaluating the Hawthorne effect in primary care, a systematic review and meta-analysis. *Front Med (Lausanne).* 2022; 9: 1033486. doi: 10.3389/fmed.2022.1033486
40. Angassa D, Solomon S, Seid A. Factors associated with dyslipidemia and its prevalence among Awash wine factory employees, Addis Ababa, Ethiopia: a cross-sectional study. *BMC Cardiovasc Disord.* 2022;22(1):22. doi:10.1186/s12872-022-02465-4
41. Luna-Castillo KP, Olivares-Ochoa XC, Hernández-Ruiz RG et al. The Effect of Dietary Interventions on Hypertriglyceridemia: From Public Health to Molecular Nutrition Evidence. *Nutrients*. 2022;14(5):1104. doi:10.3390/nu14051104
42. Tsiptsios D, Leontidou E, Fountoulakis PN, et al. Association between sleep insufficiency and dyslipidemia: a cross-sectional study among Greek adults in the primary care setting. *Sleep Sci.* 2022;15(Spec 1):49-58. doi:10.5935/1984-0063.20200124.

Citez cet article: Tshitenge B.K.W., Batina A.S., Atoba B.C., Mbo M.J-P., Kambale K.P., Losimba L.J., Kayembe T.C. Effects of Lifestyle Changes on Dyslipidemia in Patients with Metabolic Syndrome in Kisangani city, Democratic Republic of Congo. *KisMed* Mars 2025, Vol 14(1): 680-691