

Analysis of main risk factors contributing to obesity in the region of East Africa: meta-analysis

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Abstract

Background: Over a few decades obesity has become a major global health problem. Its prevalence worldwide has more than doubled since 1980. The situation is expected to worsen in the future, especially in the developing countries that experience nutrition transition due to economic growth. It contributes to reduction in malnutrition which supports an increase in obesity prevalence.

Objectives: The aim of this study was to analyse the predictors of obesity in the region of East Africa.

Methods: Meta-analysis of existing studies was used in order to find the different risk factors and their significance in obesity development. Data extracted from 16 published academic research articles described the situation in East African countries. The significance of the effect of each variable was tested by means of an asymptotic chi-square test, or Fisher's exact (factorial) test and the risk ratios were calculated.

Results: Based on the chi-square test and the risk ratios of the aggregated data, three risk factors were found to be significant in the development of obesity – gender, type of residence and socio-economic status. In East African countries, women are significantly more likely to be obese. Living in an urban area and socioeconomic status are also positively associated with obesity. Because of insufficient data three other risk factors did not prove to be of any significance – alcohol consumption, smoking and education level.

Conclusion: Conclusions of this meta-analysis confirm world trends but we also found results that are not in line with them (e.g. education). This meta-analysis confirms the huge existing research gap concerning obesity predictors in the East African region.

Keywords: Obesity, meta-analysis, East Africa.

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Introduction

Over a few decades obesity has become a major global health problem¹. According to the World Health Organi-

zation (WHO) the prevalence of obesity worldwide has more than doubled since 1980 and the increase is accelerating². The latest data from 2014 shows that more than 1.9 billion adults were overweight and of these, over 600 million were obese³. However, there are huge disparities among different geographic regions, pieces of research covering those areas and attitudes and prevention strategies against obesity. To discuss the worldwide trends of obesity, we use the WHO definition³ describing “obesity and overweight as an abnormal or excessive fat accumulation that presents a risk to health”. Body Mass Index (BMI) is used as reference standard to measure it⁴. According to the WHO³, overweight starts with a BMI equal to or more than 25 and an adult with a BMI of 30 or higher is considered obese.

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Numerous studies have recommended^{1,5-7} an urgent global action plan to create appropriate policies and raise public awareness about obesity. However, the main key to eliminating obesity is in prevention strategies because obesity is preventable through changes in behaviour⁵. The main risk factors of obesity are divided into two groups - modifiable and non-modifiable. The main focus of the prevention strategies should be on modifiable risk factors (e.g. dietary intake, physical activity, smoking, area of residence) because these are under the control of the affected population. No national success stories of obesity elimination have been reported in the past 33 years. According to Kelly et al.⁹ the population of developed countries is more prone to being obese or overweight than that of developing countries, yet it is in the latter where vast number of people are affected by this health problem^{1,10} and the situation is expected to worsen in the future¹¹⁻¹³. Nowadays, developing countries experience nutrition transition as economic growth has changed peoples' nutritional habits¹⁴. This contributes to reduction in malnutrition, which supports an increase in obesity prevalence¹⁴. To date, too little research has been done on obesity and its risk factors in developing world¹⁴. During the Nairobi conference in 2009 it was stated that African continent is in urgent need to develop appropriate health policies against obesity¹⁵. These should be based on robust research and use local approaches and traditions¹⁶.

While there has been a plethora of articles about obesity published worldwide^{2,5,9,10,12,14,17-19} and partly covering the region of Africa, for the East African sub-region any overview study has not been published yet. As the African continent is very huge it is important to focus on smaller geographical parts as they have different level of development and the predictors might play diverse roles in the prevalence of obesity.

Therefore, the main aim of the presented meta-analysis is to focus on this developing region and to analyse the risk factors of obesity prevalence in order to use the results in further micro-level studies. Thereby the authors decided to use meta-analysis and to base this research on already existing articles and their aggregated data.

Methods

Setting of the study

This study defines East Africa as the East African Com-

munity (EAC). This regional organization unites the republics of Burundi, Kenya, Rwanda, South Sudan, Uganda and Tanzania that belong to the category of low human development according to the Human Development Index (HDI)²⁰.

Search and inclusion criteria

The authors decided to use meta-analysis to cover the research gap existing in the selected region. This method was employed because during the preliminary search of documents related to the obesity in East Africa, any similar research or complex studies focusing on the trends and risk factors of obesity were not identified.

Initially the search for articles in the databases (PubMed, Medline, EBSCO) started with the following keywords, separately – obesity, BMI, overweight. Each of these three keywords was combined with “East Africa” and with each country using Boolean operators (AND). All articles published until 2014 were included into the search engine. The preliminary search discovered a vast number of research articles – 1,118 in EBSCO, 1,290 in PubMed and 16,665 in Medline (altogether 19,073). Therefore, the research team decided to narrow down the search to the level of abstracts. After this step 1,303 pertinent articles were found. At this stage duplicates were removed and titles were screened independently. 254 studies were found as appropriate. Reading all the selected abstracts was the next step. After reading them, 64 academic articles were found appropriate. The condition for inclusion of the article into this study was defined in a way that obesity had to be considered as a dependent variable explained by a number of independent variables. Full texts of these articles were read and they were screened according to STROBE statement checklist. The condition for inclusion of the article into this study was defined in a way that obesity had to be considered as a dependent variable explained by a number of independent variables. 47 studies were excluded from the analysis due to insufficient information, lacking quality or inappropriate position on obesity in the research design. Finally, 20 studies could have been included in the meta-analysis but only 16 studies contained appropriate aggregated data for extraction (see Figure 1).

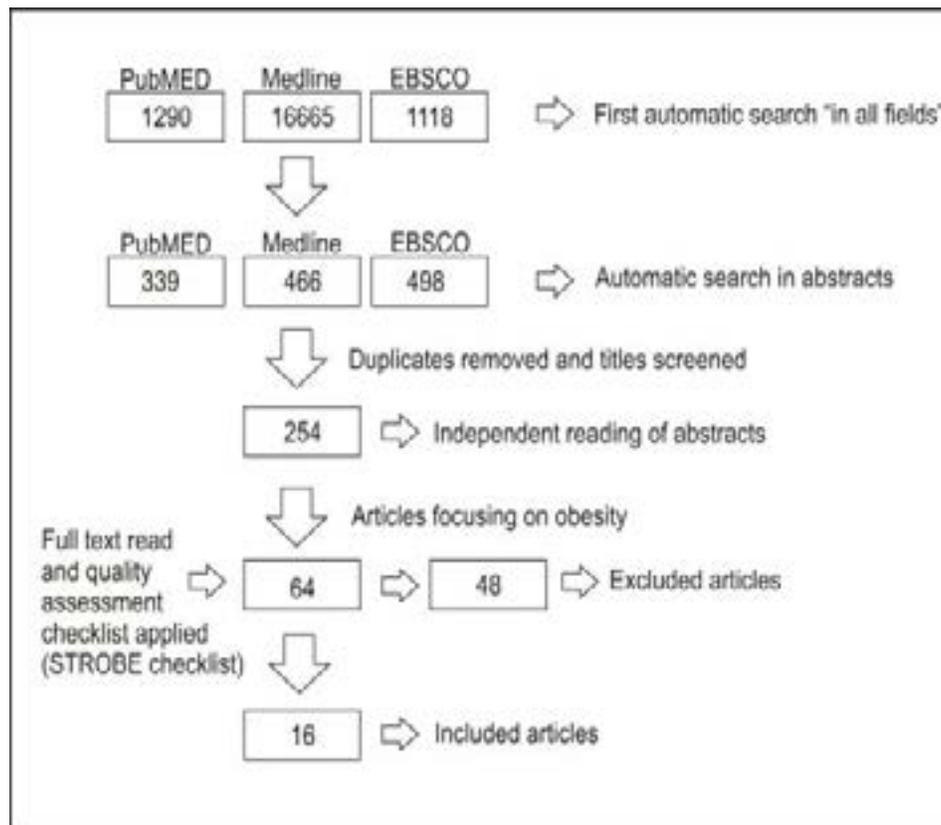


Figure 1: Articles selection process for inclusion into meta-analysis

All the authors of the selected studies were contacted by email and asked for other articles and further recommendations for the research. We received 11 replies after three rounds of email conversation. This further research did not contribute to the inclusion of any new article. The authors could work only with the aggregated data from these 16 studies as the original raw data the primary authors worked with were not accessible. Aggregated data from each study were extracted and placed in separate tables and used for the meta-analysis.

Studies included in the meta-analysis

Out of the 16 selected studies, 5 covered obesity issues in Tanzania^{21–25}, 4 considered Uganda^{26–29} and 7 described Kenya^{18,30–35} (see Table 2). These studies and their aggregated data served as starting point in the meta-analysis. No appropriate quality studies (based on STROBE statement) that covered Rwanda, South Sudan or Burundi were found. This confirms the existing research gap in East Africa.

All the studies selected for the meta-analysis focused on obesity as a dependent variable and used several different modifiable and non-modifiable risk factors to explain its prevalence (e.g. gender, age, level of education, socio-

economic status, physical activity, area of residence, alcohol use, smoking, dietary intake, household size, marital status, occupation). All the articles used cross-sectional study design and analysed the prevalence of obesity in defined populations. Some independent variables were repeated several times and overlapped in the selected articles. These were used in the presented meta-analysis. The samples in the 16 selected articles reached from 20,035 to 532,533 participants and covered age groups ranging from 3 to 68 years. Females and males were represented. The studies used different types of random sampling (cluster, multistage, stratified), with one exception – study Ojiambo et al³⁵ used convenience sampling. Different methods of data collection were applied – secondary data from national surveys, questionnaires, accelerometry, ultrasonography and anthropometric measurements.

Statistical analysis

Based on the availability of the data in the chosen articles several predictors were selected. Then their particular influence on obesity was studied separately. The predictors used are gender, education, type of residence, alcohol consumption, smoking and socioeconomic status. From each article the summary data were tabulated in sever-

al separate contingency tables. The significance of the effect was tested by means of an asymptotic chi-square test, or Fisher's exact (factorial) test in the case of a low number of subjects. These tests were applied 35 times. Then, for each predictor the available data from the articles were finally pooled together in a single contingency table and the effect of the predictor was tested by the methods described above. The level of significance was set to 0.05. The calculation of risk ratios was the second

steps in the meta-analysis. It was calculated for each study separately and later on for each variable together. The level of significance was set to 0.05. All the statistical analyses were performed using the open platform VassarStats and STATA.

Results

All the predictors studied, their definitions and analyses are described hereafter. Table 1 summarizes the final contingency table results for each predictor.

Table 1: Pooled data of the selected indicators.

Pooled data (number of studies included):	Gender (14)		Education (2)		Type of residence (9)		Use of alcohol (2)		Smoking (2)		Socioeconom ic status (6)	
	Female	Male	No education	Education	Rural	Urban	Yes	No	Yes	No	Poor	Rich
Overweight/obese	2,402	985	79	630	1,176	1,192	62	265	9	338	468	1,611
Not overweight/obese	8,150	8,408	386	2,574	5,522	1,936	258	1,347	110	1,879	2,636	3,739
Sample size	19,945		3,669		9,826		1,932		2,336		8,454	
Chi-square test	p<0.0001		p=0.536		p<0.0001		p=0.331		p=0.663		p<0.0001	
Confidence interval	(1.804,2.064)		(0.758,1.155)		(0.424,0.483)		(0.882,1.453)		(0.475,1.607)		(0.452,0.549)	

To evaluate the influence of gender in obesity, data from 14 studies^{21–28,30–33,35,36} were extracted and pooled. After calculation the risk ratio the pooled data (N=19,945) show that women are significantly more likely to be obese than men (p<0.0001; CI=(1,804; 2,064)). However, in four studies^{21,31,35,36} the effect of gender did not reach the significance level. All these four studies focused on children and adolescents. This makes sense because it takes some time for obesity to develop, thus it is more probable to find the effect in adult populations.

Data concerning the effect of education were pooled from two articles^{25,29}. On the individual level of both articles, education proved to be significant as a predictor of obesity, however the effects were the opposite. In Shayo et al²⁵, having no education was associated with a significantly (N=1,249, p=0.03) higher risk of obesity, whereas in Turi et al²⁹ the effect was the opposite but also significant (N=2420 – only the adult population, p=0.003). After pooling the data from both articles (N=3,669) and calculating the risk ratio, the significance of this predictor disappeared (p=0.536; CI=(0,758; 1,155)). Shayo et al²⁵ focused on the adult population of both genders, whereas Turi et al.²⁹ only carried out research into women and their children. It is not possible to conclude anything about the influence of education on obesity as we did not have enough appropriate data and both studies showed opposite results.

To test the effect of type of residence on obesity, data from 9 articles were extracted^{12,21,23,26,27,29–31,34,35}. Type of residence was used as dichotomic variable – rural and urban. Only in one study²⁶ did type of residence prove not to be significant. In this case, the population studied was younger adults (18-30 years). In all the other individual studies, type of residence was found to be significant, showing that people living in urban areas were more likely to be obese/overweight than those living in rural areas. When all the data were pooled (N=9,826) and risk ratio calculated, type of residence also proved to be highly significant (p<0.0001; CI=(0,424; 0,483)) with the same association as on the individual levels.

Data relating to alcohol consumption were extracted only from 2 articles^{25,26}. This variable was dichotomic in both cases (yes/no). Based on the asymptotic chi-square test, alcohol consumption was not found to be a significant predictor of obesity in either of the studies (p=0.23; p=0.74). Then the risk ratio calculation was also applied to the pooled data, (N=1,932) and the same result was confirmed (p=0.331; CI=(0,882; 1,453)). It is not possible to make further conclusion about alcohol consumption as a risk factor for obesity because only two studies could provide the data.

Concerning smoking, relevant data were extracted from two studies^{26,27}. Smoking had two different values – yes

(people smoke) and no (people do not smoke). In the first case²⁶, smoking was not found to be a significant predictor of obesity ($p=0.16$). In the second study²⁷ smoking was shown to be a significant protective factor against obesity. When all the data were pooled ($N=2,336$) and risk ratio computed, smoking was not found to be significant ($p=0.663$ CI=(0,475; 1,607)). Any further conclusion cannot be made because only two studies were included.

Socio-economic status was studied based on 6 papers^{25–27,29,31,34}. The effect was assessed by means of the

chi-square test. Based on the categorization process during the preparation of the data from each article this variable was also set into a binary system – rich/poor. In half of the studies^{25,27,29}, socio-economic status was found to be significant for obesity meaning that rich people are more likely to be obese. Conversely, data in other 3 studies^{26,31,34} did not show significance. When we pooled all the data ($N=8,454$) and counted the risk ratio, socio-economic status was found to be significant ($p=0.0001$; CI=(0,452; 0,549)), saying that the status “rich” was associated with a significantly higher risk of obesity.

Table 2: List of articles included into the meta-analysis (G – gender, E – education, R – type of residence; A – use of alcohol, S – smoking, SE – socioeconomic status)

Authors Date of publication	Aim of the study	Study design	Sample size	Name of place	Target population Age range	Predictors extracted					
						G	E	R	A	S	SE
Kenya											
Jayne et al. (2011)	characterize the nutritional status and identify socioeconomic factors and dietary habits	cross-sectional	500	Rural: Kisumu, Kenya Kombewa division	Adults 18–55	x					
Gewa (2010)	report on the prevalence of overweight and obesity among children examine the associations between childhood overweight and maternal and child – related factors	cross-sectional cluster	1,443	Rural and urban areas of Kenya.	Children 3–5	x		x			x
Christensen et al. (2008)	assess the prevalence of obesity and differences in body composition with	cross-sectional	1,430 (53% females)	Rural and urban areas of Kenya.	Adults 17–68	x		x			
Kamau et al. (2011)	determine the prevalence of overweight and obesity among primary school children	cross-sectional	5,325 (2,620 males and 2,705 females)	Urban	Children 10–15	x					
Kyallo et al. (2013)	determine the prevalence of overweight and obesity among children	cross-sectional	321	Urban (Nairobi)	Children 9–14	x					
Steyn et al. (2011)	determine the nutritional status of women assess the relationship of diet, demographic and socioeconomic factors on their weight status	cross-sectional	1,006	Rural and urban areas of Kenya (Meru, Kisumu, Nakuru, and Nairobi)	Women 15–60			x			x
Ojumbo et al. (2012)	determine habitual physical activity levels and sedentary time test for relationships between objectively measured physical activity, sedentary time, and adiposity	cross-sectional	200	Rural (Nandi region) and urban (Eldoret town) areas of Kenya	Adolescents 12–16	x		x			
Tanzania											
Muhihi et al. (2013)	assess the prevalence and determinants of obesity	cross-sectional	446	Urban: Dar es Salaam, Tanzania	Children 6–17	x		x			
Shayo and Mugusi (2011)	determine the prevalence of obesity and its associated risk factors	cross-sectional	1,249	Urban: Kinondoni municipality, Dar es Salaam, Tanzania	Adults 18–65	x	x		x		x
Mosha and Fungo (2010)	determine the prevalence of overweight and obesity	cross-sectional	222	Urban: Dodoma and Kinondoni municipalities in TZ.	Children 10–12	x					
Njelekela et al. (2009)	examine the prevalence of cardiovascular disease risk factors and their correlates	cross-sectional	209	Urban: Temeke, Dar es Salaam, Tanzania	Adults 44–66	x					
Njelekela et al. (2002)	report prevalence rates of obesity and dyslipidemia; examine important dietary contributors to obesity and dyslipidemia	cross-sectional	545	Urban: Dar es Salaam, Handeni and Moduli	Adults 46–58	x		x			
Uganda											
Peltzer and Pengpid (2011)	Overweight, obesity and associated factors in school-going adolescents	cross-sectional	5,613	Uganda and Ghana	Children 13–15	x					
Baalwa et al. (2010)	Prevalence of obesity and overweight in young adults	cross-sectional	683	rural: Kamuli urban: Kampala	Adults 18–30	x		x	x	x	x
Turi et al. (2013)	Geographic distribution of obesity	cross-sectional	2420	Uganda	2,420 adult women		x	x			x
Mayega et al. (2012)	Identification of socio-behavioral characteristics associated with being overweight or hypertensive	cross-sectional	1,653	2 districts in Eastern Uganda	Adults 35–60	x		x		x	x

Discussion

The problem of obesity is highly visible in developing countries, and especially in nowadays sub-Saharan Africa, “where socio-economic status, gender, age, parity, physical inactivity, and increased energy, fat, and sugar belong among the powerful predictors”¹⁸. Based on the meta-analysis of 16 relevant articles, this study aimed to overcome the research gap and examined the significance of different predictors of obesity in the countries of East Africa. From many different predictors mentioned in the whole research sample, only six could be analysed, one of them is a non-modifiable predictor (gender), the other five are modifiable ones. All the other five predictors are modifiable (education, type of residence, alcohol consumption, smoking and socioeconomic status) and can be influenced by behaviour and health policies.

Concerning socio-economic status the pooled results (N=8,458) are in line with other studies^{2,22,34} that also found higher socioeconomic status associated with obesity in developing countries. On the other hand, if we look at the individual studies the conclusions are not significant. In this case there were 3 studies that found an association between higher socioeconomic status and obesity and 3 that did not. This was also confirmed by Ziraba et al², who found the opposite association. Therefore the relation of socioeconomic status and obesity is not very clear. All studies included in the meta-analysis were published between 2002 and 2013, and cover both genders. However, the pooled results are not in line with the findings of Monteiro et al.⁶ whose review, published a decade ago, covered studies of obesity in the developing world between 1989 and 2003. They found that obesity was also becoming a problem of poorer people in developing countries and they concluded that there was a shift towards poor people in the development of obesity, and it was associated with an increase in national GDP (Gross Domestic Product). The discordance between these results lies in the research samples. This study focused on six specific East African countries, whereas Monteiro took into consideration very different set of developing countries (e.g. Albania, India, Brazil, China, South Africa and others countries), which are economically stronger than the six East African countries. These results show that the group of developing countries is very diverse and that there are different conclusions for different income groups, as noted by Houle.³⁷ Therefore, we emphasize that there are not enough studies to cover these problems

in Africa, where there are huge differences in GDP, and especially in East Africa with countries of low HDI.

Molarius et al.³⁸, found an inverse association between education and obesity. This association proved to be stronger in female populations. In two included studies the educational level proved to be significant in the development of obesity, but their results showed opposite directions. When the data were pooled the significance of education disappeared. If we look closer at the individual studies^{25,29} and the review of Molarius et al.³⁸, we find some similarities. Turi et al.²⁹ only used women in their research and concluded that higher education lowers the risk of obesity, while on the other hand, Shayo et al²⁵ used both genders in their research and found the opposite association. This might support the idea that when researching the role of education in obesity development, gender is an important confounder.

Type of residence appears to be highly significant in presented study, people living in urban areas in East African countries are more likely to become obese than those living in rural areas. This was also found by Ziraba et al^{2,39}. They concluded that obesity and overweight are on the rise, especially among urban populations in Sub-Saharan Africa. The same was found by Xu F, Yin X-M. and Wang Y.⁴⁰ in Nanjing, China. This effect is not surprising, taken into account “much lower rates of poverty and less energy expenditure that characterizes most areas in developing countries”³⁹.

Concerning the prevalence of obesity in association with gender, we can conclude that women in East African countries are significantly more likely to be obese than men. This is the conclusion that can be found in the majority of studies which describe the developing world⁴¹. However, this trend is different in developed countries where there are more obese men than women^{41,42}. This difference can be explained by different social and cultural values⁴¹. Regional differences can be found among developing countries when describing the rapidity of obesity development as cited by Sahn³⁹, whose study reveals that in the countries of Latin America and South Asia, obesity in women develops more quickly than in the African countries. These findings confirm the conclusions about the East African countries.

In this meta-analysis the risk ratio of the pooled data did not show any results that would allow further con-

clusions.. On the other hand, significant findings that non-smokers are more likely to become obese than smokers was found e.g. in other studies from different parts of the world^{40,43,44}. Xu et al.⁴⁰, in study from Nanjing (China), concluded that smoking is negatively associated with BMI and that those who stop smoking are at risk of gaining weight. However, many authors are concerned about such simplistic conclusions because smoking negatively influences the health status of the population.

There was no association found between alcohol consumption and obesity in this study. Generally, studies on the association between alcohol consumption and obesity show that higher alcohol consumption and especially heavy drinking leads to obesity^{45,46}. However, the amount of alcohol consumption was not studied in this case and therefore no conclusion can be drawn.

Limitations of the meta-analysis

The authors admit that the number of articles included in the meta-analysis is very small (for education, smoking and alcohol consumption only two studies with opposite direction of the predictors could be included) and this limits the strength of the results. However, this is also proof that the area of East Africa is not well covered by quality research studies. Therefore the region needs more academic focus as obesity is quickly becoming the problem of the future. For future studies it is important to obtain original data which was not possible in this case. Such data would allow the researchers to apply methods as correlation or regression analysis.

Conclusion

This study focused on a small region of 6 East African countries and the risk factors for obesity. The available research articles included in the meta-analysis allowed us to discuss six predictors of obesity/overweight in 3 countries from the defined region. For Rwanda, Burundi and South Sudan no appropriate articles were found. On one hand, this compromises the size of research sample and therefore the validity of the results for the whole East African region, on the other hand it clearly shows the existing research gap in this region.

Several of conclusions confirmed world trends but we also found results that are not in line with them. In the study, there were found four risk factors to be significant for obesity development – gender, type of residence, smoking and socioeconomic status. Alcohol consump-

tion and education level have not proved to be significant in obesity development, which is inconsistent with general conclusions found worldwide. Women, non-smokers and people living in urban areas in East Africa are more likely to be obese. Furthermore, a higher risk of obesity was also found in people with higher socioeconomic status.

One of the conclusions is that the developing countries are a very diverse group in relation to GDP, HDI and economic growth and so it is not possible to define the same trends for all of them. In this article we have researched 6 countries in the category of “low development” and their trends are very different from those positioned higher on the HDI scale.

Conflict of interest

None declared.

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