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Research Article

Assessing the Main Carbohydrate Energy Staple and Meal Frequency by Very Active Manual Workers (VAMW) in Nairobi, Kenya

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Abstract

Manual workers expend high energy in the course of their work and have to learn to balance their energy intake with expenditure. The type of food they consume determine how long they can endure labour intensive work and the number of meals they consume per day to remain productive and nutritionally healthy in the long term. Studies on energy requirement for work productivity are limited. The objective of this study was to determine main carbohydrate staple and meal frequency by Very Active Manual Workers (VAMW) in Nairobi, compared to relatively moderately active groups Civil servants (CS) and University students (US). Questionnaires were administered to a total 322 respondent categorized into the three groups: VAMW, (CS) and US. Respondents were asked to state their main carbohydrate staple from a list of 5 commonly consumed foods in Kenya Ugali, rice, chapati, Irish potatoes, bananas, and "others" [foods such as Githeri (mixed maize and beans), cassava, spaghetti, noodles, Sweet potatoes, and bread, among many alternatives]; and the number of meals they consumed per day. Results indicated Ugali (Maize meal) was the main carbohydrate staple consumed by all respondent groups. The meal frequency per day by VAMW was higher compared to CS and US respondents. Only 9% of VAMW consumed two meals a day compared to 33% of CS and 45% of US that reported taking two meals or less per day. None of the VAMW reported skipping a meal or consuming one meal per day, unlike CS and US groups where 3% and 1% respectively skipped or consumed one meal per day. There was a significant difference between the numbers of meals taken per day by VAMW compared to moderately active groups, US and CS; $F(0.05, 2,330) = 13.089$, $p < 0.0001$. A pairwise comparison of meal frequency means, using Scheffé's test, indicated a significant difference in number of meals consumed by VAMW and CS, and between VAMW and US, but no significant difference between CS and US pair. Further Post hoc analysis revealed an effect size of 0.23, F (0.05, 2,329); and a final Power (1- err prob) of 0.97. Results indicate choice of main carbohydrate energy staple and meal frequency per day is an important factor in meeting the energy requirements for very active manual workers.

Keywords: "Ugali"; Main Carbohydrate Staple; Meal Frequency; Very Active Manual Workers

Introduction

Staple foods are those that constitute the major part of a routine diet and generally supply most or all of the total energy and nutrient intake of individuals [1-3] Some staple foods around the world were adopted during the period of transition in human history, from small hunter-gatherer nomadic bands to larger agricultural settlements, between 10,000 to 3,500 years ago [3] Communities around the world have therefore identified and established preferences for specific foods as their main source of energy, mainly influenced by taste, availability, cost and convenience [4]. Human food preferences and diet have evolved and vary within, and between ethnicities [5].

According to the food exchange theory, foods of the same group can be interchanged to deliver an equivalent amount of energy in the body [6]. Carbohydrates are found in a wide array of foods with sugars, starches and fibers being the most common and abundant forms. They occur in fruits, vegetables and proteins, including nuts grains legumes and seeds, but in smaller quantities. It is therefore expected that Isocaloric foods from the same food group can be interchanged to deliver equivalent amount of energy to support an individual's activity level. However, many studies have shown that a combination of factors such as carbohydrate type, load, quantity, preparation method and combination with other nutrients affect digestion satiety and postprandial effect differently. This attributes affect choice, and activity level is one of the factors that determine choice.

Kenya is a land of great diversity in its people and cultures [7]. Each of the 44 ethnic tribes has a preference and attachment to a

particular staple diet or cuisine. In many ways, the type of staple is also a reflection and source of cultural identity and diversity [1,7,8]. The main staple diets in Kenya are based on maize, wheat, rice, Irish potatoes, bananas and beans, including millet, cassava and sorghum [9]. Maize meal locally referred to as "Ugali," has been adopted as the popular staple food consumed by over 75% of the population [10] as a reliable source of energy, regardless of social economic status "Ugali".

Ugali is a specially prepared soft mixture of milled maize (corn) flour, locally referred to as "Unga", prepared by mixing it in boiling water overheat source and baked for about 10 to 15 minutes. It basically has no additive (s), seasoning, nor sweetener. It can be prepared from whole milled or sifted maize flour alone; a mixture of different proportions of maize flour and cassava flour; or milled pure or flour mixtures of millet, sorghum and cassava [9] commonly referred to as "brown Ugali", a traditional version. However, the overwhelming reliance on maize meal staple, "Ugali", has posed a major problem in Kenya socially, economically and politically. There is a common slang that "when there is no 'Ugali,' there is no food". Shortfalls in supply and price hikes have been a source of protests and street demonstrations, especially by low income and very active persons, which at times cripples economic activities [11-14]. The wide acceptance and reliance on the maize meal is propelled by the general perception and stereotype that it is tastier, nutritious and has higher satiety compared to other common carbohydrate energy staples. Some staple foods are considered inferior in terms of energy, nutrients and organoleptic taste by some individuals and ethnic communities and national attempts to promote or draw attention to other staples have been met with resistance, grumbles and nationwide demonstrations [12,15]. Street demonstrations have been witnessed during acute shortages in the market or skyrocketing maize flour ("Unga") prices, in agitation for government interventions to sustain supply and fair pricing [12,13].

Very active manual workers expend high energy in the course of their work and require a reliable source of energy. Their choice of staple food determines energy level; the duration or level of endurance in the course of their work performance; and intervals for energy replenishment through food. Adequate energy and timely replenishment will also contribute to their nutritional health status in the long term. Hence, very active workers have to learn to balance their energy intake with expenditure as they work through number of meals taken. Studies on energy requirement for work productivity are limited. The objective of this study was to determine the choice of main staple and meal frequency level of Very Active Manual Workers (VAMW) in Nairobi, compared to relatively moderately active groups- Civil servants (CS) and University students (US) living in Nairobi, Kenya.

Methodology

Sampling, study site and target group

A purposeful sampling method was used to identify and recruit the group of very active healthy manual workers in Nairobi, as the main focus of this study. The manual workers were drawn from four companies in Industrial Area of Nairobi, who were determined to be very active due to their nature of work. The moderately active groups, acting as control groups, were Civil servants (CS) working in the Ministry of Agriculture, Livestock, Fisheries and Cooperatives and Ministry of Health offices in Nairobi; and University students from Kenyatta University, living and studying in Nairobi. The criteria for inclusion of subjects in the study was, healthy individuals aged between 18-60 years old. The Manual workers were selected from the same unit, and where most of the work performed was manual and labour intensive. Conducting the interviews within the working or study environment enabled interviewers to confirm the activity level of the respondents before commencing the interview. This also minimized significant interruption of their work or study schedule for the day. There was no discrimination between genders, as long as they were engaged in the same activity level. However, female subjects were not found among the VAMW group.

Interview questionnaires were administered at site, but most of the VAMW were interviewed during lunch break period, since most workers are paid according to the accomplished work each day. Hence, taking too much of their time would affect their pay for the specific day, although a lunch break is very important for them. Permission to interview the respondents was obtained from management prior to the visit and arrangements were made to be at the site on time. The respondents were informed of the purpose of the study and their consent sought before administration of questionnaires. Sometimes resistant respondents were motivated to get their attention to be interviewed by paying for their lunch meal after the interview. Respondents were assured that data collected would remain confidential. Interview questionnaires were first administered to determine their eligibility and to obtain relevant personal data. Each interview took an average of 15-20 minutes to complete. A priori sample size was determined using G*power version 3.1.9.4 with small effect size 0.23 [16], $\alpha = 0.05$. A total of 322 questionnaires were administered.

Selection of staple foods

According to the theory of food exchanges Wheeler., *et al*. (1996), the American Diabetes Association (2003), and The National Institute of Diabetes and Digestive and Kidney Diseases (2014) [17,18] and carbohydrate counting, food energy is obtained from carbohydrates, proteins, or oils/fats in the diet. This study focused on car-

bohydrate energy staples and used the question of "the main carbohydrate energy staple" to differentiate it from other energy giving foods, proteins and fats and oils. Some ethnic communities have milk, meat and pulses as staples. A selected number of foods commonly consumed by different ethnic groups in Kenya were used to limit the category of responses so that the respondents did not have a wide range of foods to compare and respond to. Foods that could not fit the selected category were lumped together and assigned the "others" food category. The selected carbohydrate energy giving staple foods were: Ugali, rice, chapati, Irish potatoes, bananas, and the "other" category. The "other" category option represented any other food they prefer, if not among the 5 listed foods such as Githeri (mixed maize and beans), cassava, spaghetti, noodles, Sweet potatoes, and bread among many alternatives.

Questionnaires design and interviewers

In order to determine the main energy staple food consumed most regularly, the respondents were asked to indicate the main energy staple consumed most regularly from the six selected staple foods and state the frequency of meals (number of meals) consume per day. All respondents were familiar with or understood the description of the foods in the study questionnaire. The questions required subjective responses and recall, therefore subject to errors. Hence, cross-checking and follow-up questions were incorporated to validate individual responses. The assumptions were that all the responses were independent; there were no biases, or influence during the interviewing process, and all respondents were familiar with or understood the questions and description of and foods in the study questionnaire. The minimum sample size for administration of the questionnaires was determined using G*Power version 3.1.9.4 [19] effect size of 0.23 and $\alpha = 0.05$. A total of 322 questionnaires were administered. Data was analyzed using Excel Data Analysis Tools for Descriptive Statistics and Analysis of Variance, Scheffé's test, and G*power version 3.1.9.4 for Post hoc tests.

Results

Main carbohydrate staple and Number of meals taken per day

Respondents were asked to indicate their main carbohydrate staple from a choice of six commonly consumed carbohydrate foods: *Ugali*, rice, chapati, Irish potatoes, bananas, and "others" and then indicate their meal frequency per day. The study sought to determine the main staple that enables them to fulfill their energy needs for their occupation. Results indicated that Ugali was the main carbohydrate for 90% of the VAMW. Overall, 79% of all the respondents selected "Ugali" as their main carbohydrate energy staple, followed by chapati 11%, rice at 6%, bananas 2%, and Irish potatoes and the "others" 1% each (Figure 1 and 2).

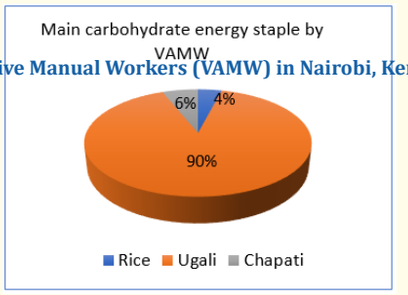

Figure 1: Respondents' responses on main carbohydrate energy staple by VAMW

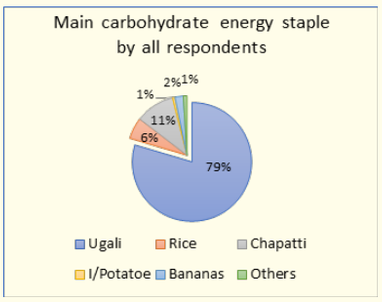

Figure 2: Respondents' responses on main carbohydrate energy staple by all groups combined.

Frequency of meals consumed per day

Interviews on Frequency of meals (number of meals) consumed per day were done to determine energy replenishment intervals based on the type of carbohydrate energy staple by the respondents. A poor choice would affect satiety and work productivity of the manual workers. The average number of meals consumed by each group was three per day. The results also indicated that the range of the number of meals per day for VAMW was 2 to 4 meals, compared to 1 to 4 meals per day for CS and US (Table 1).

Specifically, 80% of VAMW consumed three meals a day compared to 59% and 48% of CS and US, respectively (Figure 3). Only 9% of VAMW consumed two meals a day compared to 33% of CS and 45% of US that reported taking two meals or less per day. The results also indicated that 11% of the VAMW consumed more than three meals per day, compared to 8% of CS and 7% of US. None of the VAMW reported skipping a meal or consuming one meal per day, unlike CS and US groups where 3% and 1% respectively skipped or consumed on meal per day.

Statistic	Civil servants	University students	Manual Workers
Mean	2.706	2.617	3.009
Range	3	3	2
Minimum	1	1	2
Maximum	4	4	4
Count	119	107	107

Table 1: Results of the mean number of meals consumed per day by each group.

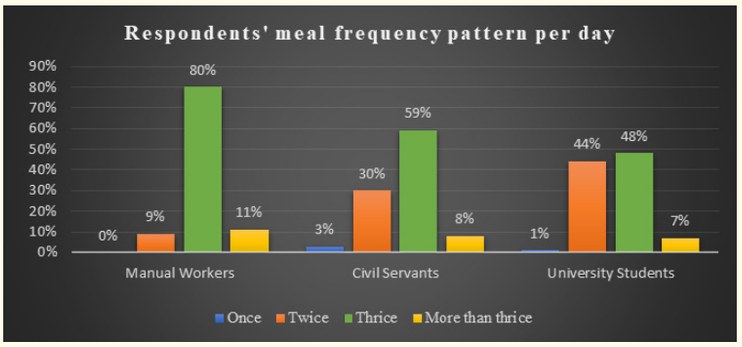

Figure 3: Summary of the meal frequency per day by group category.

Further analysis indicated a significant difference between the numbers of meals taken per day by VAMW compared to moderately active groups, US and CS; F (0.05, 2,330) = 13.089, p < 0.0001, (Table 2).

A Post hoc pairwise comparison of meal frequency means was conducted using Scheffé's test to determine which group means were significantly different. Scheffé's test indicated that there was a significant difference in number of meals consumed between VAMW and CS, and between the VAMW and US, but there was no significant difference in the number of meals consumed between CS and the US groups (Table 3). Further, Post hoc test revealed an effect size of 0.23, F (0.05, 2,329); the test statistic was 3.023 with a non-centrality parameter of 17.563, and a final Power (1- err prob) of 0.97. Figure 4 shows the distribution curve for the results.

ANOVA Summary: Single Factor						
Groups	**Count**	**Sum**	**Average**	**Variance**		
Civil servants	119	322	2.706	0.430		
University students	107	280	2.617	0.408		
Manual Workers	107	322	3.009	0.198		
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	9.122	2	4.561	13.089	0.000	3.023
Within Groups	114.986	330	0.348			
Total	124.108	332				

Table 2: Significance of differences in number of meals taken per day by the three groups.

Scheffé's critical value = 6.046186					
Category	**Group mean**	**Pair comparison**	**Difference between means**	**Scheffé's calculated value**	**Decision**
Manual Workers	3.009	Manual workers Vs University students	0.393	23.660	Significant
Civil servants	2.706	Manual workers Vs Civil servants	0.303	14.892	Significant
University students	2.617	Civil servants Vs University students	0.089	1.283	Not significant

Table 3: Pairwise comparison of mean number of meals taken by each group.

Discussion

Most studies have focused on satiety and satiation with regard to obesity and weight management, but not so much with regards to requirements as per activity level. Manual work is characterized by high intensity for long durations of muscle contractions. Beside muscle contraction, carbs supply energy to the brain and maintains mental sharpness during endurance activities. During endurance activities the body draws on its muscle glycogen, then once depleted liver glycogen is used [17]. The nature of work of VAMWs demands adequate provision of food energy. It is important that they maintain their energy level high while working to improve productivity, remain alert and maintain their nutritional health. Otherwise, low energy would affect their productivity and therefore income at work. Most manual workers work on temporary basis and earned income based on their productivity or man-days. Results indicated that most manual workers in the study preferred to eat Ugali as their main source of energy compared to the moderately active groups.

The choice of the carbohydrate energy staple and the number of meals taken per day is determined mainly by satiation and satiety level from consuming the carbohydrate energy staples. Satiation and satiety are part of the body's biological control mechanisms triggered by hormones that define appetite and hunger sensations, thereby controlling energy intake. Total energy intake is determined by the feeling of not just fullness, but also feeling less energetic for a physical activity. Both factors are therefore important in determining what the VAMW choose to eat [20]. Karalus M. (2011) defines satiety as the period between the perceived levels of fullness after you stop eating to the time you feel hungry again. Studies by both Lynch (2018); Benelam (2009); Snell H. (2018); and Holt., *et al.* (1985) indicate that satiety and satiation influence hunger and our ability to consume adequate energy for our activity level [21-23]. The study by Harry Snell (2018) explains that satiety is governed by hormones and stretch receptors in the stomach, while satiation is influenced mainly by quantity, texture, water content, protein and fiber content of the food, which signals the brain that the meal is enough. Satiation can limit the quantity of food that can be consumed at one meal. Although this study did not determine exact quantities consumed per meal, it indicates that VAMW select foods with higher caloric content and also shows a higher frequency of meals for energy replenishment compared to less active individuals. Result show that 96% of VAMW prefer Ugali and chapati, as their main carbohydrate energy staples compared to 80% determined for all groups combined. Further, the result indicated that 91% of VAMW consumed three meals or more per day, compared to 67% of CS and 55% of US (Figure 4).

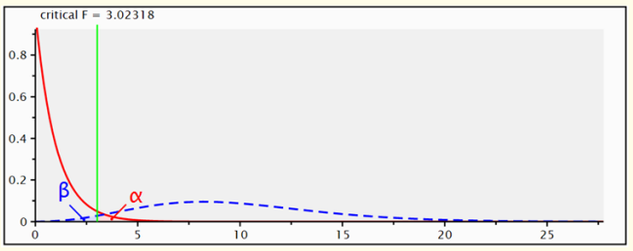

Figure 4: Distribution curve for the number of meals taken per day.

According to the food exchange theory, foods from the same group can be interchanged with one another to deliver equivalent amount of energy in the body. However, different factors such as carbohydrate type, carb factor, load, quantity, preparation method, and combination of other nutrients affect total digestion time, postprandial glycemic index, satiety index, and total glucose energy released to aid in work activity. Most foods such as cereals, legumes, roots and tubers, milk, fruits and vegetables contain some amount of carbohydrate. Carbohydrate load represents the exact amount of carbohydrate content in a food portion. The "carb factor" represents the exact amount of carbohydrate found in 1 gram of carbohydrate food by weight and corresponds to the amount of carbohydrate that is available to raise the blood glucose level, excluding fibre (NDDK, 2014). Most countries have developed food composition tables, which is quite useful in determining the carbohydrate content of a food serving. For the purposes of meal planning Kawamura., *et al.* (2015) indicates that the 'carb factor' is a precise way of counting calories conveyed from a meal [6]. How-

ever, it should be noted that high glycemic index foods are not inappropriate for long endurance activities and people with low insulin sensitivity. High glycemic index foods may be ideal for treating hypoglycemia and for rapid recovery from high endurance activities or intense muscular activity actions [24]. It is recommended to eat carbohydrates before and after intense exercise to maintain energy. For healthy persons, the recommended targets are at least 50 percent of energy from carbohydrates, which can be adjusted to accommodate increased energy needs or activity level by reducing on fats but staying within the limits for protein.

Expected application of the results

Scientifically, this study will deepen the understanding of the food exchanges theory, glycemic index of foods, satiety and satiation with regard to different ethnic staple foods consumed in Kenya. This study provides empirical evidence regarding the preference of different carbohydrate energy staples by very active individuals and the postprandial effect. It also answers some concerns on beliefs and stereotypes of individuals and ethnic communities about energy and nutrient value of their ethnic staple foods, activity level and work endurance of individuals. Correcting the perception of various staple foods can improve utilization and demand for other staple foods, leading to increased production and therefore food security and economic development.

This study can influence the choice of carbohydrate foods in meals based on activity level or intervals of meal consumption to contribute to staying active or remaining alert. In the case of very active manual workers, the results will be useful in providing guidance on the types of staple foods necessary to maintain health and replenish energy during or after strenuous work performance. Having accurate information and knowledge, will impart positive effects on individual food choices and combinations of foods for the desired post-prandial effect for better nutritional health, work performance and productivity. It will also be applicable in addressing the challenges related to pressure on maize as the main staple in Food Security Policy and in planning to influence the nutrient density of the food plate.

However, further research is needed to ascertain the postprandial blood sugar levels after consuming isocaloric carbohydrate foods at set intervals and based on the number of meals taken per day to further verify the findings of this study. Policy measures are necessary to ensure food security and nutrition of VAMW is sustained at all times. In most developed countries technology has been embraced to carry out heavy work. This implies that investing in machinery can be a more sustainable option, rather than drawing heavily on human energy stores for labour intensive manual work.

Conclusion

Ability to balance individual energy consumption and expenditure is important. The level of energy supply affects concentration span, endurance and duration of intensive strenuous work or activities. This study indicates a correlation between the choice of main carbohydrate energy staple and activity level of individuals. The energy requirement for the VAMWs is very high and heavy work output is driven by energy supply from the food they eat. The results of this study confirms the claim that Ugali may have higher satiety compared to some commonly consumed staples in Kenya and may influence the existing stereotypes and choice as the main carbohydrate energy staple. In most epidemiological studies, the focus is on hunger, satiety, obesity, weight management, glycemic index, exercise, and malnutrition; but not so much has been done on the energy requirements for individuals requiring energy for high manual activity levels. In this study, Ugali stands out as the undisputed preferred main carbohydrate energy staple food for very VAMW in Nairobi to stay healthy as they work and to earn an income.

Having adequate nutrition knowledge and information is necessary to enable individuals make the best choices among alternative staples and combinations that can enhance satiety to support their level of activity and work performance, to prevent drawing heavily on their energy and nutrient stores, leaving them unhealthy and unproductive. Providing accurate information will influence food choices by VAMW and enable dietary diversification to access essential food nutrients for better nutritional health.

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