

Nutritional Status and its Related Factors in Khalwa Residents, Khartoum State, Sudan

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Abstract

Khalwa is a Quranic male boarding school in Sudan. Our research aimed to assess the nutritional status and its related factors in Khalwa residents of Khartoum State. A facility-based cross-sectional study was implemented in two localities of Khartoum State. A multistage sampling technique was used to selected 1273 residents. At first level, four khalwa were selected in the seven localities of Khartoum State through a stratified random sampling technique. At second level, in each of the khalwa selected, all the residents fulfilling the inclusion and exclusion criteria were included in the study. The collected data were firstly summarized numerically and graphically. Then, associations/differences among variables were determined through chi-square tests and ANOVA. A multinomial logistic regression established the relationship between the nutritional status of the residents and its related factors. All statistical tests were considered statistically significant when $p < 0.05$. The age of the 1273 residents varied from 6 to 60 years with an average age of 15 years. Their mean body mass index of $16.6 \text{ kg/m}^2 \pm 3.4$ ranged from 7.8 kg/m^2 to 34.0 kg/m^2 . Undernourished were 73.8% of the residents, 23.9% were well nourished and 2.3% were overweight/obese. The statistically significant factors related to the nutritional status of the residents were age (under-nourished $p = 0.000$; well-nourished $p = 0.004$), status in the khalwa ($p = 0.001$ vs $p = 0.075$), resting time ($p = 0.002$ vs $p = 0.038$), hand washing practices ($p = 0.165$ vs $p = 0.011$) and exercising ($p = 0.032$ vs $p = 0.027$). The food practices, despite their contributions to the model were not statistically significant ($p > 0.05$). The nutritional status in khalwa should be translated urgently in a community-directed intervention based on a partnership involving the affected communities, political and administrative authorities, national, bilateral and international donors to overcome the burden of malnutrition.

Keywords: *Almajiri; Body Mass Index; Khalwa; Nutrition; Quranic School*

Abbreviation

BMI: Body Mass Index; UNICEF: United Nations Children's Emergency Fund; WASH: Water Sanitation and Hygiene; WHO: World Health Organization

Introduction

Malnutrition remains a challenge with one out of three people directly affected by underweight, vitamin and mineral deficiency, overweight, obesity and diet-related non-communicable diseases. These conditions increasingly coexist in a nation, community, household, or

even in the same individual across the life course. While more than 1.9 billion adults were overweight or obese worldwide in 2015, 462 million were underweight. In 2016, 155 million children < 5 years were affected by stunting, 52 million were experienced wasting and 41 million were overweight [1,2]. According to the Human Rights Watch there was about 5 million children attending thousands of Quranic boarding schools across the globe [3]. The denomination of Quranic schools varies across continents and countries. In Bangladesh, India, Pakistan, Singapore, and Somalia, the Quranic schools are named “madrasah/madarassa”, called “tsangaya” in Nigeria, “daaras” in Mauritania and Senegal; in Egypt they are known as “alkotab”, and commonly named “khalwa” in Sudan [4-8]. Khalwa is a historical Islamic educational institution in Sudan, which despite its contribution to the Islamic education has experienced little change over the years [4,5]. It mostly depends on Islamic endowments, individual donations and charities. The quality of life of the residents is impacted by poor environmental and sanitation conditions associated to an unsatisfactory diet. It remains the main center of educational opportunity for many remote rural Sudanese people [9,10].

Various researchers were interested in the nutritional status in institutions because of its direct health impact, particularly in Quranic schools. A study [11] assessed the socioeconomic, demographic and health problems on a sample of 377 Quranic school students (almajiri) in Northern Nigeria. The authors reported that 68.4% of the participants belonged to poor socioeconomic families, 62.8% came from polygamous families, 59.7% had urinary tract infection and 17.8% suffered from skin disease. 60.4% took bath once a month and 66.7% did not practice tooth brushing. In the same country, the evaluation of the nutritional status and prevalence of intestinal schistosomiasis [12] on a sample of 360 “almajiri” pointed out that severe malnutrition (body mass index < 15.3) prevailed more in infected children (n = 67) than in non-infected (n = 293) with a prevalence of respectively 75.0% and 67.0%. These findings were recently confirmed by Mohamed A., *et al.* in East Nile locality of Khartoum State, Sudan, when assessing the health and biosocial aspects of children of Quranic schools. Their results revealed that in students harboring schistosomiasis, 34.5% suffered from stunted growth while 17.0% were malnourished [13]. Further health problems in Quranic schools were reported through a comparative cross-sectional study seeking to evaluate the prevalence and correlates of psychiatric disorders on a sample of 213 “almajiri” and 200 public school pupils [7]. The findings revealed a mean number of traumatic events significantly higher (1.38 ± 1.05) among “almajiri” compared to public school pupils (0.87 ± 0.83) with *p-value* < 0.001. Depression, enuresis, substance use remained significantly higher among almajiri; while separation anxiety was significantly experienced by public school children

Nutritional status is multifactorial involving both nutritional, biological, environmental, psychological and physical factors. In East Nile locality, a descriptive cross-sectional study on a sample of 384 students of four Khalwa assessed the water and environmental sanitation services [14]. The findings revealed that 75% of the Khalwa had just two meals/day, regarding the sources of safe drinking water, wells remained the first source for 50% of the Khalwa (n = 4). Half of the Khalwa did not have containers for storing solid waste, which consequently was burned. Despite, 96.4% of the students were educated solely in Khalwa, only 2/3 (67.2%) knew about the importance of personal hygiene. In Gezira State (Sudan), an analytical cross-sectional study on a sample of 180 students of a Quranic school revealed a prevalence of anemia of 88.33%; it was higher (47.11%) in children aged 11 - 14 years than in those of 7-10 years (38.15%) and 15 - 18 years (3.07%) [15]. Kheir AEM., *et al.* on a sample of 406 males residing in a Quranic school, found a prevalence of night blindness of 24.0%, conjunctival xerosis was 12.5% and Bitot’s spots was 1.0%. A statistically significant association (*p* = 0.023) was found between the duration of stay in the institute and the development of night blindness [16].

Khalwa, a dedicating place for teaching and memorization Quran, is a close environment where live students, teachers, supervisors under the overall responsibility of a “sheikh”. Our research aimed to assess the nutritional status of the residents and its associated factors in four Khalwa, distributed in two of the seven localities of Khartoum State, Sudan.

Materials and Methods

A facility based cross-sectional study was implemented in Khartoum State divided in three main cities which are namely Khartoum, Bahri and Omdurman with an estimated population of 7,993,851 people in 2018 per Sudan Census Bureau of Statistics (<http://www>.

cbs.gov.sd/). The State comprises seven localities which are Karari, Ombadda, Omdurman, Bahri, Shareq Alneel (East Nile), Al Khartoum and Jaba Awliya. Sudan household survey of 2008 (<http://www.ilo.org/microdata/index.php>) reported that the age group 0 to 17 years represented 50.9% of the country-wide population, under this assumption, 4,068,870 children are between 0 to 17 years in Khartoum State. According to UNICEF Sudan (<https://www.unicef.org/sudan/>), 9.3% of the children were out of primary school in Khartoum State, which correspond to 3,690,465 enrolled in primary schools. 15712 residents are enrolled in the Khalwa distributed in the seven localities of Khartoum State as per the Ministry of General Education and Instruction. The reported breakdown was the following Karari (2873 residents), Ombadda (1618), Omdurman (1777), Bahri (1257), Shareq Alneel (5988), Al Khartoum (813) and Jabaal Awliya (1386).

A multistage sampling technique was used to select the study participants. At first level a stratified random sampling technique was used to select the Khalwa proportionally to size of each locality based on the number of residents as reported by the Ministry of General Education and Instruction. The two localities with the highest estimated sample size, based on the formula $n = N/1+Nd^2$ were included in the study. Table 1 revealed the localities (Sharq Alneel and Karari) selected and the estimated sample of 726 residents distributed in Khalwa of Sharq Alneel (sample size 375 residents) and Karari (351 residents). In the field, the review of the registers of enrollment revealed that the four Khalwa totalized 2726 residents instead of 8861 which represented 30.8% of the reported residents. At second level, decision was taken to include in the study all the residents registered and living in the Khalwa. Were excluded from the study, the residents from non-selected Khalwa, those attending daily the Khalwa but not living in and those who refused to participate in the study. In the overall, a sample of 1273 residents were included in the study and distributed as the following Karari Almanara (34.7%,442/1273), Karari Mohamed Alhabib (25.4%), Shareq Alneel Khalifa Mohamed Zein Alabdin (17.7%) and Shareq Alneel Maseed Elsheikh (22.2%).

Locality code	Locality	Total residents	n
2	Sharq Alneel	5988	375
3	Karari	2873	351
3	Omdurman	1777	327
3	Ombadda	1618	321
1	Jabaal Awliya	1386	310
2	Bahri	1257	303
1	Al Khartoum	813	268
	Total	15,712	2,255

Table 1: Total number of Khalwa residents per the Ministry of General Education and Instruction as at 2018 and estimated sample size by locality of Khartoum State.

The data were collected through a standardized interviewer-administrated tool, firstly developed in English and translated in Arabic for easy understanding by the study participants. The questionnaire was pre-tested prior to field implementation in two non-selected Khalwa geographically distributed in the localities of Al Khartoum and Ombadda.

The questionnaire comprised two parts. Part 1 related to the institution, enabled to collected data, from each Khalwa through observations (including the review of the registers and census books) and interviews to gather statistics on residents, accommodation, sources of water and energy as well as environmental hygiene and sanitation including waste management. These data, informing on the profile of the khalwa surveyed, were excluded from the current analysis. Part 2 recorded data related to the study participants through four subheadings, the sociodemographic characteristics of the participants, their mode of living, their nutritional practices and their anthropometric measures (height, weight and body mass index). The anthropometric measures weight (kg) and height (cm) were recorded for all the residents in using a floor type weight scale (model Zt-120). The weight and height were measured in having each resident in minimum

clothes, without shoes and having each the head upright and looking straight forward. The data were computerized in using a template developed through EPI-Info™ 7.1.5.2 2. The statistical package for social sciences (SPSS version 23) was used to summarize the data numerically and graphically. Chi-square tests were used to determine association/difference between categorical variables; an ANOVA determined the statistical association between continuous and categorical variables. A multinomial logistic regression was performed to establish the relationship between the nutritional status of the residents and a set of explanatory variables which were age, status of the resident (students, supervisors and teachers), duration of living in khalwa, resting time (calculated as the difference between the time of waking up and the one of going to bed), physical activities and nutritional practices of the residents. All statistical tests were considered as statistically significant when $p < 0.05$.

Results

Characteristics of the Residents

Table 2 displayed the distribution of the study population (n = 1273 males) by khalwa. The participants were predominately students (94.4%, 1201/1273); their median age of 15 years ranged from 6 to 60 years. Their duration of living in khalwa ranged < 1 to 35 years with a median of 1 year.

Variable	Number	%
Khalwa (n = 1273)		
Karari Almanara	442	34.7
Karari Mohamed Alhabib	323	25.4
Shareq Alneel Khalifa Mohamed Zein Alabdin	225	17.7
Shareq Alneel Maseed Elsheikh	283	22.2
Age in years (n = 1265)		
Median	15	
Min-Max	6-60	
< 15 years	630	49.8
15-24 years	566	44.8
25-34 years	41	3.2
≥ 35 years	28	2.2
Status (n = 1273)		
Student	1201	94.4
Supervisor	36	2.8
Teacher	36	2.8
Duration of residence in years (n = 1273)		
Median	1	
Min-Max	0*-35	
< 1 year	451	35.4
1 - 4 years	760	59.7
≥ 5 years	62	4.9

Table 2: Characteristics of the study participants living in four Khalwa of Khartoum State (n = 1273).

*< 1 year.

Mode of living of Khalwa residents

The resting time of the residents ranged from 5 to 8 hours with an average of 6.7 hours \pm 0.7. A statistically significant difference ($p = 0.000$) was found between resting time and status of the residents. It was 6.6 hours \pm 0.6 for students, 7.0 hours \pm 0.8 for teachers and 7.1 hours \pm 0.8 for supervisors.

The residents of the Khalwa performed five main activities namely "reading and writing Quran", walking, cooking, cleaning their respective Khalwa and washing their clothes. "reading and writing Quran was the main activity of all the residents (100.0%, 1273/1273). Walking was practiced daily by 95.9% (1212/1273), daily cooking by 59.6% (716/1202). Cleaning their respective Khalwa was an activity implemented once a week by 78.2% (995/1273) of the residents and 94.5% (1203/1273) washed their clothes once a week.

Hygiene and sanitation as reported by the Khalwa residents

Of the 1273 participants, 67.6% (861/1273) practiced hand washing without soap, 31.0% (394/1273) with soap, 0.8% (10/1273) reported washing hands with sand and 0.6% (8/1273) did not practice hand washing. The practice of hand washing was regrouped as "good practice" when participants washed hands with soap and the three others reported practices was labeled as "poor practice". In the overall, 69.0% (879/1273) of the residents had poor practice of hand washing and the remaining 31.0% (394/1273) had good practice. 23.2% (294/1267) of residents brushed once a day their teeth with paste and the remaining 76.8% (973/1267) brushed their teeth without paste. Teeth brushing with paste was statistically different ($p = 0.000$) across Khalwa and the status of residents. Student had the lowest prevalence of teeth brushing with paste (19.7%, 235/1195).

Diet and food intakes in the Khalwa

In general, the residents had two meals a day, breakfast at 10:00 am for 96.5% (1228/1273) and at 11:00 am for the remaining 3.5% (45/1273). The second meal (lunch) was served at 5:00 pm for the majority (99.5%, 1267/1273) and at 4:00 pm for 6 residents (0.5%). Thirty-two (2.5%) residents had dinner at 10:00 pm. Of those, 52.8% were teachers, 27.8% supervisors and 0.2% students. Almost all the residents (96.6%, 1227/1270) reported that they needed extra meals; they were students (100.0%, 1119/1119), teachers (52.8%, 19/36) and supervisors (25.7%, 9/35).

"Assida", dish made with sorghum and "mullah", a sauce made with okra and dried meat were consumed on a daily basis by respectively 99.6% (1261/1266) and 99.7% (1263/1267) of the residents. Meat soup with bread, called "saliga-fatta" was served either occasionally (55.2%, 703/1273) or weekly (44.5%, 566/1273). Beans were served occasionally (54.8%, 480/876) or daily (44.6%, 391/876). The frequency of consumption of bread was occasionally (95.1%, 523/550), daily (2.7%, 15/550) and weekly (12/550). Dried fruits (dates) were consumed occasionally (72.3%, 910/1258), daily (27.3%, 343/1258) and weekly (0.4%, 5/1258). Fresh fruits consumers were < 1% (0.4%, 5/158), all were teachers.

The most popular drink consumed was tea by 74.8% (943/1273) on a daily basis and occasionally by 24.7% (312/1261) of the residents. Coffee was reported to be drunk every day by 14.8% (67/454) of the residents and occasionally by 85.2% (387/454). The millet porridge, known as "nashah" was served weekly to all (1273/1273) the residents, whereas milk was consumed daily by 1.2% (15/1273). Natural juices, made from hibiscus flowers or baobab dried fruits were served daily to 1.9% (24/1273).

Anthropometric measurements of the Khalwa residents

The median weight of the residents ($n = 1272$) of 36 kg ranged from 11 to 107 kg. According to the Khalwa, the weight varied from 34.3 kg \pm 13.7 to 43.0 kg \pm 12.6. The students had a mean weight lower (37.6 kg \pm 12.7) than the teachers (60.1 kg \pm 16.6) and the supervisors (62.6 kg \pm 24.5). The height of the residents of 1.5 meter ranged from 1.1m to 1.9m; this average varied across Khalwa from 1.4m \pm 0.1 to 1.5m \pm 0.2. The mean body mass index (BMI) of the residents ($n = 1272$) of 16.6 \pm 3.4 kg/m² ranged from 7.8 kg/m² to 34.0 kg/m². The cutoff points proposed by the World Health Organization (WHO) [17] were used to classify the nutritional status of the residents. The

majority (73.8%, 939/1272) were underweight (BMI < 18.5 kg/m²), 23.9% (304/1272) had a normal weight (BMI 18.5 - 24.9 kg/m²), 2.0%, (25/1272) were overweight (BMI ≥ 25 kg/m²) and 0.3% (0.3%, 4/1272) were obese (BMI ≥ 30 kg/m²).

Based on WHO classification, the BMI was regrouped in three categories namely undernourished (underweight), well nourished (normal weight) and overweight/obesity. 73.8% (939/1272) of the residents were undernourished, 23.9% (23.9%, 304/1272) were well nourished and 2.3% (29/1272) were overweight/obesity (Table 3).

Variable	Nutritional status			Total	% under- nourished
	Undernourished	Well nourished	Overweight/Obesity		
Khalwa					
Shareq Alneel Khalifa Mohamed Zein Alabdin	193	23	8	224	86.2
Karari Almanara	346	86	10	442	78.3
Shareq Alneel Maseed Elsheikh	187	90	6	283	66.1
Karari Mohamed Alhabib	213	105	5	323	65.9
Total	939	304	29	1272	73.8
Status of the residents					
Teacher	11	15	9	35	31.4
Supervisor	11	12	13	36	30.6
Student	917	277	7	1201	76.4
Total	939	304	29	1272	73.8
Age group of the residents					
< 15 years	589	41	0	630	93.5
15 - 24 years	329	230	7	566	58.1
25 - 34 years	9	23	8	40	22.5
≥ 35 years	4	10	14	28	14.3
Total	931	304	29	1264	73.7
Duration of living in Khalwa					
< 1 year	333	115	3	451	73.8
1 - 4 years	584	168	8	760	76.8
≥ 5 years	22	21	18	61	36.1
Total	939	304	29	1272	73.8

Table 3: Nutritional status of the residents (n = 1273) according to Khalwa, status, age and duration of living in their respective institution.

Relationship between the nutritional status of Khalwa residents and its related I factors

A multinomial logistic regression was performed to assess the relationship between nine factors and the nutritional status of the residents. This later was grouped as under-nourished (73.8%, 939/1272), well-nourished (23.9%, 304/1272) and overweight/obesity (2.3%, 29/1272). The nine predictors used were age of the residents in years, duration of living in Khalwa (years), status of the residents, resting time in hours, hand washing practices, exercising, food intake measured as meals made from beans and “saliga-fatta” and having dates. The reference subpopulation for nutritional status in the multinomial regression model was “overweight/obesity” which was compared with the subpopulations “under-nourished” and “well-nourished” for each of the predictive factors.

The sub-model under-nourished-overweight/obesity indicated that age ($p = 0.000$), status of the residents ($p = 0.0001$), resting time ($p = 0.002$) and exercising ($p = 0.032$) were statistically associated to the nutritional status of the residents. Having dates, despite not statistically significant, contributed to explain the nutritional status of the residents by 4.4 times ([95% CI: 0.965 - 20.316] $p = 0.056$). Others contributing factors were eating salitiga-fatta ([OR = 2.804, 95% CI: 0.12 - 65.265], $p = 0.521$), hand washing practice [OR = 0.369, 95% CI: 0.09 - 1.508, $p = 0.165$] and having meals made with beans [OR = 0.246, 95% CI: 0.031 - 1.964, $p = 0.186$] (Table 4).

Subpopulation	Variable	B	Std. Error	Wald	df	p	OR	95% CI OR	
								Lower	Upper
Under-nourished	Intercept	15.072	5.549	7.377	1	0.007			
	Age of residents in years	-0.251	0.05	25.441	1	0.000	0.778	0.705	0.858
	Duration of living in Khalwa (years)	0.071	0.069	1.061	1	0.303	1.074	0.938	1.0f23
	Status of the residents	2.028	0.607	11.159	1	0.001	7.602	2.313	24.994
	Resting time (hours)	-1.786	0.581	9.467	1	0.002	0.168	0.054	0.523
	Hand washing practice	-0.996	0.718	1.926	1	0.165	0.369	0.09	1.508
	Exercising	-1.045	0.487	4.606	1	0.032	0.352	0.135	0.913
	Meals made from beans	-1.402	1.06	1.75	1	0.186	0.246	0.031	1.964
	Saliga-fatta	1.031	1.606	0.412	1	0.521	2.804	0.12	65.265
	Having dates	1.488	0.777	3.664	1	0.056	4.428	0.965	20.316
Well-nourished	Intercept	15.233	5.339	8.14	1	0.004			
	Age of residents (years)	-0.104	0.036	8.499	1	0.004	0.901	0.84	0.966
	Duration of living in Khalwa (years)	-0.051	0.056	0.848	1	0.357	0.95	0.852	1.059
	Status of the residents	0.756	0.425	3.168	1	0.075	2.13	0.926	4.9
	Resting time (hours)	-1.156	0.559	4.284	1	0.038	0.315	0.105	0.94
	Hand washing practice	-1.787	0.706	6.407	1	0.011	0.167	0.042	0.668
	Exercising	-1.006	0.454	4.913	1	0.027	0.366	0.15	0.89
	Meals made from beans	-0.842	1.044	0.651	1	0.42	0.431	0.056	3.331
	Saliga-fatta	-0.393	1.512	0.068	1	0.795	0.675	0.035	13.074
	Having dates	0.379	0.732	0.269	1	0.604	1.461	0.348	6.13

Table 4: Multinomial regression model predicting the nutritional status of Khalwa residents based on nine factors with overweight/obesity as reference subpopulation.

Whereas the sub-model well-nourished-overweight/obesity revealed that age [OR = 0.901, 95% CI: 0.84 - 0.966, $p = 0.004$], resting time [OR = 0.315, 95% CI: 0.105 - 0.94, $p = 0.038$], hand washing practice [OR = 0.167, 95% CI: 0.042 - 0.668, $p = 0.011$], exercising [OR = 0.366, 95% CI: 0.15 - 0.89, $p = 0.027$] had all a statistically significant association with the nutritional status of the residents. Factors not statistically significant but contributing to explain the nutritional status of the residents were status of the residents (OR = 2.13, [95% CI: 0.926 - 4.9, $p = 0.075$]), and having dates (OR = 1.5, [95% CI: 0.348 - 6.13, $p = 0.604$]). The duration of living in Khalwa, the meals made with beans or eating saliga-fatta, were not statistically significant ($p > 0.05$) (Table 4).

In the overall, the nutritional status of the Khalwa residents were statistically associated with their age (under-nourished $p = 0.000$; well-nourished $p = 0.004$). The status of the residents statistically significant ($p = 0.001$) in under-nourished was not statistically significant ($p = 0.075$) in well-nourished subpopulation. The resting time was statistically associated with the nutritional status in both under-

nourished and well-nourished with a *p-value* of respectively 0.002 and 0.038. Hand washing practices not statistically associated with the nutritional status in under-nourished ($p = 0.165$) were statistically associated with the nutritional status in well-nourished subpopulation ($p = 0.011$). A statistical significant association was found between nutritional status and exercising in both subpopulations (exercising in under-nourished $p = 0.032$ vs exercising in well-nourished $p = 0.027$) with a contribution to the model of respectively -1.045 and -1.006.

Discussion

In our study, the residents, all males ($n = 1273$) with an average age of 15 years (range: 6 - 60 years), were teachers (2.8%), supervisors (2.8%) and students (94.4%). This last population had an average age of 14.6 years \pm 3.8 (range: 6 - 38 years). The residents had two meals/day with 96.6% in need of extra meals. This was in line with Mohamed., *et al.* [14] who indicated that two meals were daily served in 75.0% of the khalwa and 25.0% had one meal per day. In other institutional settings, the numbers of meals served to secondary school students varied from two meals (10.5%) to \geq three/daily (1.4%) with 88.1% having three meals/day [18]. Assida (99.6%) and mullah (99.7%) were the foods daily served to the residents whereas saliga-fatta, were served occasionally. Nutritional practices varied from cultures and societies. Kheir AEM., *et al.* [16] reported that in a Quranic boarding school in Sudan, diet consisted most of a staple cereal (sorghum or millet) and "mullah". Our results revealed that the resting time of the residents ranged from 5 to 8 hours with an average of 6.7 hours \pm 0.7. This average was lower (6.6 hours \pm 0.6) in the group of students than in teachers (7.0 hours \pm 0.8) and supervisors (7.1 hours \pm 0.8) with a statistically significant difference ($p = 0.00$) between the status of the residents and their resting time. Musaiger AO., *et al.* [19] in their research on obesity, dietary habits, and sedentary behaviors among adolescents in Sudan reported that 28.0% (112/400) of the participants slept for < 7 hours/day and 72.0% (288/400) had \geq 7 hours sleep. Regarding the physical activities, 95.9% of our study participants reported walking daily, cooking was daily performed by 59.6% predominately students; 94.5% of the participants washed their clothes once a week and 78.2% cleaned their institution once a week. In assessing the nutritional status of secondary school adolescents aged 13 - 18 years, Abdalla MA., *et al.* [18] reported that 73.8% of their study population ($n = 210$) practiced physical activities and 26.2% did not. The frequency of the physical activities was daily (47.6%), two to three times/week (26.2%) and never (26.2%). The types of physical activities performed were predominately football (51.0%) followed up by swimming (19.0%), jogging (2.9%) and walking (1.0%).

Regarding hygiene and sanitation, 31.0% of our study population had a good practice of hand washing, 23.2% of the residents brushed once a day their teeth with paste. In their study on water and environmental sanitation services available to Khalwa, Mohamed., *et al.* [14] revealed that 98.4% of the students practiced hand washing with not all of them using soap. The benefits of brushing teeth were not known by 9.4% and 90.6% recognized the religious prescription of teeth brushing. The mean BMI of the residents ($n = 1272$) of 16.6 \pm 3.4 ranged from 7.8 to 34.0; it varied across Khalwa, status and age of the residents with a statistically significant difference ($p = 0.000$). 73.8% of the residents were undernourished, 23.9% were well nourished and 2.3% were overweight/obese. In Sudan, various authors discussed the nutritional status in different institutions and across age groups Ahmed FBM., *et al.* [20] found that 87.2% of children had normal nutrition status and the remaining 12.8% suffered from malnutrition whereas Musaiger AO., *et al.* [21] revealed that 20.5% the study population were underweight, 14.7% were overweight and 1.7% were obese. Ali A., *et al.* who used anthropometry as an indicator of nutritional status of Sudanese school children (6 - 9 years) [22] found that underweight was 22.34% and obesity 2.13% with no marked gender variation. Mohamed A., *et al.* indicated that 34.0% and 17.0% of the study participants were respectively underweight and malnourished [13]. Elsewhere in the literature [12], the prevalence of severe malnutrition among "almajiri" population prevailed more in infected children with intestinal schistosomiasis (75.0%) than in non-infected (67.0%). Ganganahalli P., *et al.* [23] found in a sample of 176 children of a private school that 84.1% had normal body mass index, 10.2% were overweight and 5.7% were obese. Whereas in Iran, through a screening program to assess the health and nutritional status of 2596 school children, Rezaeian S., *et al.* [24] revealed a prevalence of wasting of 3.1%, underweight of 9.48% and stunting of 2.85%. The high prevalence (73.8%) of underweight among the residents of the four Khalwa we surveyed could be related to the economic deterioration Sudan had been experiencing during the last past four years. The limitations related to our study were its restriction to the foods practices, the hygiene and sanitation conditions of

the residents; in the other hand, the health conditions including mental status of the residents were not investigated. Despite those limitations, the factors related to the nutritional status of the residents were assessed through a multinomial regression analysis which revealed that age of the residents (undernourished $p = 0.000$; well-nourished $p = 0.004$), their status (undernourished $p = 0.001$; well-nourished $p = 0.075$), their resting time (undernourished $p = 0.002$ vs well-nourished $p = 0.038$), their practice of handwashing (undernourished $p = 0.165$ vs well-nourished $p = 0.011$), and their physical activity (undernourished $p = 0.032$ vs well-nourished $p = 0.027$) were the statistically significant contributors related to the nutritional status of Khalwa residents. The food practices despite their contributions to the model were not statistically significant ($p > 0.05$).

Conclusion

Khalwa offers an opportunity of learning to low socioeconomic children; furthermore, as an institution dedicating to memorizing the Quran; it was surprising to found a high proportion of undernourished predominately in < 15 years in such close environment. This nutritional status of the residents of Khalwa should be translated urgently into proper actions to overcome the burden of malnutrition through a public-private partnership for implementing nutritional and water sanitation and hygiene (WASH) programme alongside with education.

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Conflict of Interest

No financial interest or conflict of interest.

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