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Awareness and barriers to cancer services in a low-income country: A cross-sectional study in Sudan

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Abstract:

Background: Cancer represents a significant public health challenge in Sudan, with rising incidence and mortality rates. Despite its impact, cancer awareness remains suboptimal, and barriers to early detection and timely healthcare-seeking persist, contributing to delayed diagnoses and poor outcomes.

Aim: This study aimed to assess cancer awareness, knowledge of risk factors and symptoms, and identify barriers to cancer care among adults in Khartoum State, Sudan.

Methods: A population-based, descriptive cross-sectional study was conducted from January to February 2022 in Khartoum State. A total of 418 Sudanese adults aged 18 years and older, without prior cancer diagnoses, were selected through multistage cluster random sampling. Data were collected via face-to-face interviews using a modified and validated Arabic version of the Cancer Awareness Measure (CAM). Descriptive statistics, Mann-Whitney U, Kruskal-Wallis tests, Chi-square, and multiple linear regression were performed. Statistical significance was set at $p < 0.05$.

Results: The median knowledge score of cancer symptoms was 12 (IQR: 6). While 86.1% recognised a breast lump as a warning sign, only 40.1% identified persistent cough. Significant barriers to healthcare-seeking [E1] included fear of social stigma (81.5%) and preference for traditional medicine (74.9%). Women reported higher rates of stigma and preference for traditional remedies ($p < 0.05$). Knowledge of symptoms was significantly associated with region of origin and occupation, with medical professionals and individuals from Western Sudan scoring higher ($p < 0.05$). The regression model identified preference for traditional medicine as the strongest predictor of lower cancer awareness ($p < 0.001$).

Conclusion: This study highlights gaps in cancer awareness and the pervasive influence of social stigma and traditional medicine on healthcare-seeking behaviours in Sudan. Culturally tailored education programs, strengthened screening initiatives, and collaboration with community and religious leaders are critical to improving cancer awareness and early detection.

Keywords: cancer prevention; Sudan health; screening programs

Introduction:

Cancer remains a major global health issue, responsible for an estimated 9.7 million deaths worldwide in 2022, with roughly one in five people expected to develop the disease during their lifetime [1]. Sub-Saharan Africa faces a disproportionate burden: cancer mortality rates in the region are among the highest globally, largely because most cases are diagnosed at advanced, incurable stages [2]. In Sudan, GLOBOCAN estimates for 2024 reported approximately 41 022 new cancer cases and 25 766 cancer deaths [3] with breast and colorectal cancer among the five most common malignancies nationally [4] and cervical cancer occurring at a rate of 8.7 per 100,000 annually [5]. As in much of Africa, Sudan's cancer burden is projected to rise further with population ageing and the adoption of lifestyle factors associated with economic transition, including tobacco use, unhealthy diets, and physical inactivity [6].

Cancer screening is crucial for reducing cancer mortality and morbidity [7]. However, Sudan's cancer prevention and early detection infrastructure remains underdeveloped [5,8]. Despite efforts to enhance breast cancer screening and early detection in Sudan [9,10], widespread misconceptions persist about breast self-examination (BSE), clinical breast examination (CBE), and mammography, limiting their uptake within the Sudanese population [9].

These gaps in awareness and access translate directly into delayed diagnosis. Across Africa, cultural beliefs, cancer-related stigma, preference for traditional or alternative remedies, and limited access to diagnostic services contribute to patients presenting at advanced disease stages [11], and poor cancer survival in Sudan has been attributed largely to this pattern of late presentation [12,13]. Identifying the factors associated with delayed presentation is important for developing interventions to promote earlier diagnosis. However, evidence from Sudan is limited. Studies from low- and middle-income countries have consistently identified poor awareness of cancer symptoms, fear of a cancer diagnosis, and reliance on traditional medicine as common reasons for delayed care-seeking [14]. In Sudan, the available evidence is largely limited to breast cancer, where most women experience long patient-related delays before presenting with advanced disease [15]. Beyond breast cancer, little is known about awareness of cancer symptoms and risk factors or the barriers to seeking medical care among the general Sudanese population and across different cancer types.

This study aimed to assess awareness of cancer symptoms and risk factors, as well as barriers to cancer care-seeking, among adults in Khartoum State, Sudan, to inform the development of targeted awareness campaigns and early diagnosis strategies.

Methods:

Study design and setting:

This population-based descriptive cross-sectional study was carried out between January and February 2022 to assess cancer awareness and barriers to cancer care in Khartoum State.

Participants:

Study participants were Sudanese adults aged 18 years and older. To maintain focus on cancer-naïve individuals, participants with a prior cancer diagnosis were excluded.

The sample size was determined to be 384 participants using the formula: $n = Z^2 P(1-P)/e^2$, with assumptions of a 50% response distribution, a 5% margin of error, and a 95% confidence interval. To account for a 10% non-response rate, the final sample size was adjusted to 422.

A multistage cluster random sampling method was employed, with a single neighbourhood serving as the cluster. Initially, four localities—Khartoum locality, Jabalawliaa locality, Sharq Al-Neel locality, and Ombada locality—were randomly selected. Subsequently, one administrative unit was chosen from each locality through simple random sampling, followed by the selection of one neighbourhood from each unit. Houses within the neighbourhoods were then chosen using systematic random sampling, with every third house being selected wherever the housing arrangement permitted. We interviewed one adult from each household.

Questionnaire design and data collection:

The data were collected using the Cancer Awareness Questionnaire (CAM) with an added section related to socio-demographic characteristics.

The original CAM questionnaire was developed and validated by Stubbings et al. [16], and the Arabic version used in this study was based on the translation by Al-Azri et al. [17]. The added section was validated by experts who revised it for relevance, accuracy, and appropriateness.

The CAM questionnaire comprises three sections: the first with 12 questions evaluating knowledge of risk factors, the second with 10 questions assessing awareness of warning symptoms, and the third addressing perceived barriers to seeking medical help. The 10 questions assessing knowledge about symptoms were used to calculate the knowledge about symptoms scale. The total scale has a range of 0-20, as “Yes” was coded to 2, “I don’t know” was coded to 1, and “No” was coded to 0.

Data were gathered through face-to-face interviews.

Data analysis plan:

The data were entered into Excel forms, then cleaned using SPSS version 21. A normality test was performed for continuous data, which are: age and the knowledge scale, where the Kolmogorov normality test indicated nonnormal variables (P value was <0.001 for all of them). Then descriptive statistics and frequency tables were used to describe the data. Mann-Whitney test and Kruskal-Wallis one-way ANOVA were used to study the differences between means for socio-demographic data, knowledge about risk factors, barriers, and screening regarding the knowledge scale. Chi-square and Fisher exact tests were used to study the associations between barriers and knowledge about cancer regarding different socio-demographic data. Multiple linear regression was also used to study the factors affecting the knowledge about cancer symptoms scale. In all tests, a P value of less than 0.05 was indicated as a significant result.

Ethics statement:

This study was approved by the Research Ethics Committee of the Faculty of Medicine, University of Khartoum. Informed consent was obtained from all participants. The research was conducted in accordance with the principles stated in the Declaration of Helsinki

Results:**Sociodemographic and General Characteristics of the Study Participants:**

A total of 418 participants took part in this study, with a response rate of 99.1%. The median age of participants was 27 years, with an interquartile range of 20 years. The majority (64.1%) were female. Approximately half of the participants were single (52.4%), while 43.0% were married. Most participants resided in the Omdurman locality (27.0%) and Khartoum locality (26.8%). The majority originated from Northern and Central Sudan (42.9% and 28.2%, respectively). More than half (52.3%) have graduated from university (45.1% are fresh graduates and 7.2 are in their postgraduate studies). Most participants (60.6%) had an income of less than 100,000 SDG (\$ 166.39 USD). Half (50.1%) had a relative with cancer diagnosis, and 9.7% had a friend who had cancer (**Table 1**).

Knowledge about Cancer Symptoms:

The median score for knowledge about cancer symptoms was 12, with an interquartile range of 6. Over half of the participants identified the following as cancer signs: presence of an unexplained lump (86.1%), unexplained pain (56.1%), difficulty swallowing (52.5%), non-healing ulcer (56.1%), and unexplained weight loss (61.9%). Responses varied for other symptoms, with 49.2% recognising bleeding as a sign and 40.1% identifying persistent cough (**Table 2**).

Association between Sociodemographic Data and Knowledge Scales:

Significant associations were found between knowledge of cancer symptoms and both ethnic origin and occupation (p-value = 0.025 and <0.001, respectively). The highest median knowledge scores were reported among participants from Western Sudan and those working in the medical field (**Table 1**).

Barriers to Healthcare-Seeking Behaviour and gender:

The most commonly cited barriers were fear of social stigma (81.5%), preference for traditional medicine over conventional treatments (74.9%), and negative past medical experiences (70.1%) (**Table 3 and 4**).

There were significant associations between gender and barriers to healthcare-seeking behaviour, including social stigma and preference for traditional remedies (p-value = 0.007 and 0.010, respectively). Females tend to have a higher percentage of suffering from social stigma and preference for traditional remedies as barriers (71.5% and 65.7%, respectively) (**Table 4**).

Knowledge about risk factors and factors affecting it:

The highest cited risk factors by the participants were smoking (96.6%), alcohol (81.5%), exposure to another person smoking (72.3%) and eating too much red or processed meat (53.2%). All risk factor knowledge questions were found to statistically affect the symptom knowledge scale (p-value < 0.05) except the question about the most common age to get cancer (p-value=0.088). Participants who showed high knowledge about cancer symptoms tend to also know about the cancer risk factors (for example: smoking, not eating many fruits or vegetables, being overweight, close relative with cancer, alcohol, etc) (**Table 5**).

Knowledge about screening and factors affecting it:

Almost half of the participants didn't know about the status of bowel cancer screening program (51.9%) and cervical cancer screening program (51.6%). But the majority admitted the existence of a breast cancer screening program (88.5%) (**Table 6**). Regarding the Cancer symptoms knowledge scale, all screening items were significantly associated with the scale (p-value < 0.05). Having a higher median knowledge about cancer symptoms were associated with correct answers regarding bowel cancer and breast cancer screening, but not for cervical cancer screening (**Table 6**).

Regression Model for knowledge about Cancer symptoms:

A multiple regression model was formed for socio-demographic data and health care seeking behaviours. Factors included in the model were the ones that yielded a p-value less than 0.25 in the

Mann-Whitney tests. The regression model was statistically significant (p -value=0.001) with R square value of 0.076. The factors that were significantly affecting the knowledge scale in the model were: origin (p -value =0.043) and preference of traditional remedies over chemical treatments (p -value= < 0.001) (**Table 7**).

Discussion:

This study examined cancer awareness and barriers to health-seeking behaviour among adults in Khartoum State, Sudan. Participants had moderate awareness of cancer symptoms and risk factors but limited knowledge of cancer screening services. Many participants believed that organised breast cancer screening is available in Sudan, despite the absence of a national screening programme, and similar misconceptions were observed for cervical and bowel cancer screening. The barriers to health-seeking reported most frequently were social stigma associated with a cancer diagnosis and preference for traditional or alternative medicine.

Most participants reported a monthly income of less than 100,000 SDGs (approximately USD 175). This level of income may affect access to cancer-related care, as patients and their families often experience financial difficulties due to the direct and indirect costs of cancer treatment [18,19]. Nearly half of the participants reported having a family member diagnosed with cancer, reflecting the impact of cancer on Sudanese households. In 2020 alone, Sudan recorded 27,382 new cancer cases and 17,055 cancer-related deaths [2].

Most participants correctly identified classic cancer symptoms such as the presence of a lump and weight loss. However, they were less likely to recognise less classic, "vague" symptoms, such as persistent cough, hoarseness of voice, and unexplained bleeding, similar to other populations [17,20,21].

Participants originating from Western Sudan had higher knowledge scores for cancer symptoms than those from other regions. This finding was not explained by regional differences in cancer burden, as available epidemiological data indicate that cancer incidence is highest in Northern State rather than Western Sudan [6]. One possible explanation is the long-standing presence of humanitarian organisations in western Sudan, particularly in Darfur and Kordofan, where health education activities may have improved awareness of cancer symptoms [22]. However, this explanation remains speculative and requires further investigation. Although place of origin remained independently associated with

symptom knowledge after adjustment, the effect size was small, suggesting that its contribution to overall variation in knowledge was modest.

Medical practitioners had higher knowledge of cancer symptoms than participants in other occupations, which is consistent with their training and professional exposure. In contrast, having a relative or friend with cancer was not associated with greater symptom awareness. This differs from previous studies that reported higher awareness among individuals with a family history of cancer [23,24]. A possible explanation is the stigma associated with cancer diagnosis in low- and lower-middle-income countries, which limits discussions about it [25].

Nearly three-quarters of participants believed that cancer is unrelated to age. This misconception may have important clinical implications, as failure to recognise the increased cancer risk associated with ageing may result in early symptoms being attributed to normal ageing rather than prompting timely medical evaluation, thereby delaying diagnosis [26,27].

The most widely recognised cancer risk factors among participants were smoking, alcohol consumption, and exposure to secondhand smoke, consistent with previous studies [28,29]. Although tobacco smoking is relatively uncommon in Sudan, with a prevalence of 9.7% compared with the global prevalence of 22.3%, awareness of smoking as a cancer risk factor was high [30,31]. This may reflect sustained public health messaging on the harms of tobacco use. Similarly, alcohol consumption is uncommon in Sudan, with per capita consumption well below the global average [32].

In contrast, awareness of infection-related risk factors was limited. Only 35.6% of participants identified HPV as a cancer risk factor, and only 54.9% recognised HBV. These findings are important in the Sudanese context, where HPV and HBV account for a substantial proportion of the national cancer burden. Cervical cancer is the second most common cancer and the second leading cause of cancer-related death among women in Sudan, with most cases attributable to persistent infection with high-risk HPV genotypes [5]. Likewise, Sudan remains highly endemic for HBV, a leading cause of hepatocellular carcinoma [33].

Contrary to expectations, given the absence of an organised national cancer screening programme in Sudan, most participants (88.5%) incorrectly believed that a breast cancer screening programme exists. Smaller proportions reported the same for cervical (42.4%) and bowel (37.3%) cancer screening. This pattern is unlikely to reflect random guessing, as responses differed by cancer type. This finding may reflect the greater visibility of breast cancer awareness activities in Sudan, where awareness campaigns and early detection initiatives have been implemented despite the absence of an organised population-

based screening programme. Consequently, participants may have confused these activities with a formal screening programme.

When asked about the appropriate age for screening initiation, participants tended to select the youngest option available. This pattern suggests a tendency toward guessing and underscores the need for careful interpretation of the results.

The most frequently reported barriers for health-seeking behaviour were fear of social stigma, followed by preference of alternative medicine and having a bad past experience with a doctor. Fear of cancer diagnosis is the most commonly reported barrier to health-seeking among patients with symptoms suggestive of cancer in many countries [34,35]. This fear is explained by individuals' tendency to view cancer as a death sentence [36].

Use of complementary and alternative medicine is a known barrier to health-seeking [37,38]. A previous study conducted in Sudan reported that 9.8% of women diagnosed with breast cancer initially sought traditional treatment, leading to delays in their presentation [15]. A qualitative synthesis investigating the potential reasons behind this phenomenon identified several contributing factors. These included recommendations from family and friends, familial sanction, perceived benefits and compatibility of traditional treatments, the credibility of traditional healers, reservations about Western medicine, and delays within the healthcare system [39].

This study has several limitations. First, it was conducted in Khartoum State and was designed to be representative of its adult population rather than the Sudanese population as a whole, which may limit the generalizability of the findings. Nevertheless, as the country's largest and most populous state before the 2023 conflict, Khartoum included residents from across Sudan. Second, data were collected before the outbreak of the war in April 2023. The conflict has disrupted healthcare services and public health activities and is likely to have influenced both cancer awareness and barriers to care-seeking; therefore, these findings should be considered a pre-conflict baseline. Finally, awareness and barriers were assessed using a questionnaire, and some responses may have been influenced by guessing or may not reflect actual healthcare-seeking behaviour.

Conclusion:

This study offers crucial insights into cancer awareness & barriers to cancer care within Khartoum State, the capital of Sudan, revealing knowledge gaps and misconceptions. These findings underscore the urgent need for culturally appropriate educational programs designed to increase understanding of cancer risk factors, screening modalities, and treatment options. By effectively bridging these

knowledge gaps, we can substantially improve early detection rates, treatment outcomes, and overall cancer control in Sudan.

Declarations:

Ethics approval and consent to participate:

To confirm that all methods were carried out by relevant guidelines and regulations of the declaration of Helsinki (the last one was the 64th WMA General Assembly, Fortaleza, Brazil, October 2013), ethical approval was obtained from the ethical committee of the community medicine department at the university of Khartoum. Informed written consent was collected from all participants.

Consent for publication:

Not applicable.

Availability of data and materials:

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

Competing interests:

No competing interests as defined by BMC, or other interests that might be perceived to influence the results and/or discussion reported in this paper.

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Authors' contributions:

M.A.S.K., MS.S.A., M.Y.M.E. (conceptualization, methodology, data analysis and interpretation, writing- reviewing and editing)

M.H.E., S.S.A. (data interpretation, writing- original draft)

A.H.M. (data collection and interpretation, writing- original draft)

L.H., M.M.A.E., S.S.A (writing- reviewing and editing)

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Table 1: Univariate Analysis of Sociodemographic Factors and Knowledge about Cancer Symptoms (N= 418)

Variables	Frequency (valid percentage%)	Cancer symptoms knowledge	
		Median±IQR ^a	p-value
Socio-demographic data			
Age	27±20 ^b	^c	0.644 ^d
Gender:			0.432
Male	147(35.9%)	11.73±7.00	
Female	263(64.1%)	12.00±6.00	
Marital Status:			0.540
Single	218(52.4%)	12.00±6.00	
Married	179(43.0%)	12.00±7.00	
Divorced	10(2.4%)	11.50±6.00	
Widow	9(2.2%)	14.00±7.00	
Residency:			0.255
Khartoum locality	112(26.8%)	12.00±5.00	
Sharq Al-neel locality	104(24.9%)	11.00±5.00	
Jablawlya locality	89(21.3%)	12.00±5.00	
Omdurman locality	113(27.0%)	12.00±7.00	
Origin:			0.025*
Northern Sudan	178(42.9%)	11.00±6.00	
Central Sudan	117(28.2%)	12.00±7.00	
Western Sudan	88(21.2%)	12.21±6.00	
Eastern Sudan	25(6.0%)	12.00±8.00	
Southern Sudan	7(1.7%)	10.00±7.00	
Education level:			0.552
Illiterate	7(1.7%)	13.00±5.00	
Primary School	17(4.1%)	11.00±6.00	
Secondary School	175(42.0%)	12.00±5.00	
University	188(45.1%)		
Post-graduates	30(7.2%)	12.00±6.00	
		11.35±6.00	
Income (in thousands of SDGs):			0.499
15-30	168(41.4%)	11.48±5.00	
30-60	0(0%)	^c	
60-100	78(19.2%)	12.00±7.00	
100-120	60(14.8%)	11.67±4.50	
>120	100(24.6%)	12.00±7.00	
Occupation:			< 0.001**
Healthcare Professional	45(10.8%)	16.00±7.00	
Officer	95(22.8%)	10.00±6.00	
Skilled Trades	54(13.0%)	12.00±6.00	
Student	128(30.8%)	12.00±5.50	
Not Employed	94(22.6%)	12.00±6.00	
Have you ever been diagnosed with cancer?			^c
Yes	0(0%)	^c	
No	413(100%)	12.00±6.00	

Have any of your close relatives ever been diagnosed with cancer? Yes No	206(50.1%) 207(49.9%)	12.00±5.00 11.53±5.00	0.129
Did any of your friends get cancer before? Have any of your friends ever been diagnosed with cancer? Yes No	40(9.7%) 373(90.3%)	12.00±6.00 12.00±5.00	0.493

^a Interquartile range

^b median ± Interquartile range

^cNot applicable

^dp-value is calculated using Sperman correlation test.

*p-value less than 0.05

**p-value less than 0.01

Table 2:The table shows statistics of knowledge about cancer symptoms (N= 418)

Variables	Frequency (valid percentage%)
Could a lump that appears without explanation be a symptom of cancer? No I don't know Yes	38(9.1%) 20(4.8%) 359(86.1%)
Do you think continuation of unexplained pain can be a sign of cancer? Can ongoing pain without a clear cause be a symptom of cancer? No I don't know Yes	115(27.7%) 67(16.1%) 233(56.1%)
Do you think presence of unexplained bleeding can be a sign of cancer? No I don't know Yes	117(28.3%) 93(22.5%) 203(49.2%)
Do you think presence of Persistent cough or hoarseness can be a sign of cancer? No I don't know Yes	172(41.2%) 76(18.2%) 169(40.5%)
Do you think presence of continues Change in bowel or bladder habits can be a sign of cancer? No I don't know Yes	141(33.9%) 100(24.0%) 175(42.1%)
Do you think presence of Persistent difficult swallowing can be a sign of cancer? No I don't know Yes	119(28.7%) 78(18.8%) 218(52.5%)

Do you think Change in the appearance of a mole can be a sign of cancer? No I don't know Yes	113(27.4%) 101(24.5%) 198(48.1%)
Do you think presence of Nonhealing sore can be a sign of cancer? No I don't know Yes	102(24.5%) 80(19.2%) 234(56.3%)
Do you think Unexplained weight loss can be a sign of cancer? No I don't know Yes	106(25.4%) 53(12.7%) 258(61.9%)

Table 3: The table shows statistics of health seeking behavior barriers for the participants and the univariate analysis regarding knowledge about cancer symptoms(N= 418)

Variables	Frequency (valid %)	Agreement %	Cancer symptoms knowledge	
			Median±IQR ^a	P value
which one of the following prevent you from going to doctor				
The possibility of having cancer is frightening. Strongly agree Agree Neutral Disagree Strongly disagree	 46(11.1%) 86(20.7%) 44(10.6%) 113(27.2%) 126(30.4%)	31.8%	 12.00±4.00 11.00±6.00 12.00±5.00 11.53±5.00 12.00±7.00	0.247
The cost of the tests will be requested and their results worries me. Strongly agree Agree Neutral Disagree Strongly disagree	 98(23.6%) 86(20.7%) 39(9.3%) 125(29.9%) 67(16.0%)	44.3%	 12.50±7.00 11.00±6.00 12.00±7.00 11.73±5.00 10.62±6.00	0.208
The potential side effects of treatment terrify me Strongly agree Agree Neutral Disagree Strongly disagree	 90(21.8%) 85(20.6%) 31(7.5%) 117(28.3%) 90(21.8%)	42.4%	 13.00±6.00 11.42±5.00 11.00±8.00 12.00±5.00 11.00±6.00	0.016*
Limited access to healthcare facilities		40.4%		0.363

and the high cost of services			12.00±6.00 12.00±5.00 12.00±5.00 11.23±7.00 11.42±5.00	
Strongly agree Agree Neutral Disagree Strongly disagree	81(19.5%) 87(20.9%) 52(12.5%) 91(21.9%) 105(25.2%)			
The social stigma associated with a cancer diagnosis is a significant concern.		81.5%		0.267
Strongly agree Agree Neutral Disagree Strongly disagree	209(50.4%) 129(31.1%) 27(6.5%) 26(6.3%) 24(5.8%)		12.00±7.00 11.00±5.00 12.00±5.00 12.60±6.00 10.50±7.50	
Hospitals suffer from inadequate expert healthcare professionals and infrastructure.		33.9%		0.038*
Strongly agree Agree Neutral Disagree Strongly disagree	79(19.0%) 62(14.9%) 38(9.1%) 98(23.6%) 139(33.4%)		13.00±6.00 12.00±6.00 12.00±4.00 11.00±6.00 11.33±6.00	
Lack of confident in the efficiency of doctor-patient communication regarding cancer diagnosis and treatment options.		48.2%		0.011*
Strongly agree Agree Neutral Disagree Strongly disagree	90(21.7%) 110(26.5%) 66(15.9%) 64(15.4%) 85(20.5%)		13.50±6.00 12.00±5.00 11.50±4.00 10.00±6.00 11.57±8.00	
Preference of traditional remedies over the chemical treatments		74.9%		< 0.001**
Strongly agree Agree Neutral Disagree Strongly disagree	201(48.6%) 109(26.3%) 42(10.1%) 28(6.8%) 34(8.2%)		12.00±6.00 11.00±5.00 11.00±7.00 9.00±5.50 11.00±4.20	
The lack of a broader support system makes me worry about being a burden on those close to me.		54.2%		0.130
Strongly agree Agree Neutral Disagree Strongly disagree	122(29.5%) 102(24.7%) 44(10.7%) 85(20.6%) 60(14.5%)		12.00±6.00 11.00±5.00 13.00±6.00 11.00±6.00 11.00±7.00	
The absence of early symptoms in many cancers.		35.8%		0.262
Strongly agree Agree Neutral	76(18.5%) 71(17.3%) 48(11.7%)		12.00±7.00 12.00±6.00 14.00±7.00	

Disagree	113(27.5%)		12.00±5.00	
Strongly disagree	103(25.1%)		11.00±4.00	
I've had a negative experience with a doctor in the past.		70.1%		0.221
Strongly agree	158(38.3%)		12.00±6.00	
Agree	131(31.8%)		12.00±5.00	
Neutral	50(12.1%)		12.00±8.00	
Disagree	40(9.7%)		11.00±6.00	
Strongly disagree	33(8.0%)		10.00±7.00	

^a Interquartile range

^b Fisher exact test is used

**P value less than 0.01

*P value less than 0.05

Table 4: Univariate analysis for barriers that prevent going to doctor against sex and residency, education (N= 418)

Variables	Frequency (valid %)	Females		Residency			
		Frequency(%)	p-value	Khartoum(%)	Omdurman(%)	Others(%)	p-value
which one of the following prevent you from going to doctor:							
The possibility of having cancer is frightening.			0.656				< 0.001**
Strongly agree	46(11.1%)	25(55.6%)		7(15.2%)	15(32.6%)	24(52.2%)	
Agree	86(20.7%)	55(65.5%)		25(29.1%)	12(14%)	49(57%)	
Neutral	44(10.6%)	29(67.4%)		17(38.6%)	10(22.7%)	17(38.6%)	
Disagree	113(27.2%)	70(62.5%)		35(31%)	19(16.8%)	59(52.2%)	
Strongly disagree	126(30.4%)	83(67.5%)		27(21.4%)	57(45.2%)	42(33.3%)	
The cost of the tests will be requested and their results worries me.			0.380				< 0.001**
Strongly agree	98(23.6%)	67(69.8%)		19(19.4%)	50(51%)	29(29.6%)	
Agree	86(20.7%)	52(62.7%)		31(36%)	14(16.3%)	41(47.7%)	
Neutral	39(9.3%)	25(69.4%)		6(15.4%)	9(23.1%)	24(61.5%)	
Disagree	125(29.9%)	81(64.8%)		40(32%)	21(16.8%)	64(51.2%)	
Strongly disagree	67(16.0%)	37(55.2%)		16(23.9%)	19(28.4%)	32(47.8%)	
The potential side effects of treatment terrify me			0.894				< 0.001**
Strongly agree	90(21.8%)	60(69%)		12(13.3%)	55(61.1%)	23(25.6%)	
Agree	85(20.6%)	51(61.4%)		20(23.5%)	18(21.2%)	47(55.3%)	
Neutral	31(7.5%)	20(64.5%)		11(35.5%)	7(22.6%)	13(41.9%)	
Disagree	117(28.3%)	74(64.3%)		42(35.9%)	17(14.5%)	58(49.6%)	
Strongly disagree	90(21.8%)	57(64%)		26(28.9%)	16(17.8%)	48(53.3%)	
Limited access to healthcare facilities and the high cost of services			0.283				< 0.001**
Strongly agree	81(19.5%)	48(60%)		8(9.9%)	46(56.8%)	27(33.3%)	
Agree	87(20.9%)	63(73.3%)		25(28.7%)	19(21.8%)	43(49.4%)	
	52(12.5%)	35(68.6%)		16(30.8%)	9(17.3%)	27(51.9%)	

Neutral Disagree Strongly disagree	91(21.9%) 105(25.2%)	61(60.4%) 23(25.6%)		32(35.2%) 31(29.5%)	18(19.8%) 21(20%)	41(45.1%) 53(50.5%)	
The social stigma associated with a cancer diagnosis is a significant concern.			0.007**				< 0.001**
Strongly agree Agree Neutral Disagree Strongly disagree	209(50.4%) 129(31.1%) 27(6.5%) 26(6.3%) 24(5.8%)	148(71.5%) 79(62.7%) 12(48%) 12(46.2%) 11(47.8%)		51(24.4%) 40(31%) 7(25.9%) 5(19.2%) 9(37.5%)	76(36.4%) 4(14.8%) 8(30.8%) 8(33.3%) 51(24.4%)	82(39.2%) 72(55.8%) 16(59.3%) 13(50%) 7(29.2%)	
Hospitals suffer from inadequate expert healthcare professionals and infrastructure.			0.156				< 0.001**
Strongly agree Agree Neutral Disagree Strongly disagree	79(19.0%) 62(14.9%) 38(9.1%) 98(23.6%) 139(33.4%)	51(66.2%) 46(75.4%) 22(59.5%) 64(66.7%) 79(57.7%)		7(8.9%) 15(24.2%) 11(28.9%) 38(38.8%) 41(29.5%)	47(59.5%) 17(27.4%) 6(15.8%) 25(25.5%) 18(12.9%)	25(31.6%) 30(48.4%) 21(55.3%) 35(35.7%) 80(57.6%)	
Lack of confident in the efficiency of doctor-patient communication regarding cancer diagnosis and treatment options.			0.411				< 0.001**
Strongly agree Agree Neutral Disagree Strongly disagree	90(21.7%) 110(26.5%) 66(15.9%) 64(15.4%) 85(20.5%)	58(65.9%) 72(67.9%) 43(66.2%) 42(66.7%) 47(55.3%)		10(11.1%) 30(27.3%) 20(30.3%) 22(34.4%) 30(35.3%)	54(60%) 20(18.2%) 11(16.7%) 17(26.6%) 11(12.9%)	26(28.9%) 60(54.5%) 35(53%) 25(39.1%) 44(51.8%)	
Preference of traditional remedies over the chemical treatments			0.010*				0.152
Strongly agree Agree Neutral Disagree Strongly disagree	201(48.6%) 109(26.3%) 42(10.1%) 28(6.8%) 34(8.2%)	130(65.7%) 16(48.5%) 19(46.3%) 17(65.4%) 16(48.5%)		49(24.4%) 34(31.2%) 12(28.6%) 8(28.6%) 8(23.5%)	69(34.3%) 19(17.4%) 11(26.2%) 7(25%) 7(20.6%)	83(41.3%) 56(51.4%) 19(45.2%) 13(46.4%) 19(55.9%)	
The lack of a broader support system makes me worry about being a burden on those close to me.			0.937				< 0.001**
Strongly agree Agree Neutral Disagree Strongly disagree	122(29.5%) 102(24.7%) 44(10.7%) 85(20.6%) 60(14.5%)	79(66.9%) 66(64.7%) 27(61.4%) 53(64.6%) 36(61%)		16(13.1%) 22(21.6%) 19(43.2%) 30(35.3%) 24(40%)	58(47.5%) 19(18.6%) 9(20.5%) 15(17.6%) 12(20%)	48(39.3%) 61(59.8%) 16(36.4%) 40(47.1%) 24(40%)	
The absence of early			0.528				0.021*

symptoms in many cancers.	76(18.5%)	51(68%)		13(17.1%)	34(44.7%)	29(38.2%)	
Strongly agree	71(17.3%)	42(60%)		18(25.4%)	18(25.4%)	35(49.3%)	
Agree	48(11.7%)	30(63.8%)		13(27.1%)	9(18.8%)	26(54.2%)	
Neutral	113(27.5%)	67(60.4%)		35(31%)	31(27.4%)	47(41.6%)	
Disagree	103(25.1%)	70(70%)		30(29.1%)	21(20.4%)	52(50.5%)	
Strongly disagree							
I've had a negative experience with a doctor in the past.			0.102				< 0.001**
Strongly agree	158(38.3%)	100(64.9%)		28(17.7%)	68(43%)	62(39.2%)	
Agree	131(31.8%)	86(66.7%)		42(32.1%)	26(19.8%)	63(48.1%)	
Neutral	50(12.1%)	36(73.5%)		16(32%)	7(14%)	27(54%)	
Disagree	40(9.7%)	23(59%)		14(35%)	8(20%)	18(45%)	
Strongly disagree	33(8.0%)	15(45.5%)		10(30.3%)	4(12.1%)	19(57.6%)	

^bFisher exact test is used

**P value less than 0.01

*P value less than 0.05

Table 5: The table shows statistics of knowledge about cancer risk factors and screening programs and the univariate analysis regarding knowledge about cancer symptoms ,sex,residency and having relative with cancer (N= 418)

Variables	Frequency (valid %)	Cancer symptoms knowledge	
		Median±IQR ^a	P value
Knowledge about cancer risk factors:			
smoking can increase the risk of getting cancer? No I don't know Yes	7(1.7%) 7(1.7%) 403(96.6%)	5.00±12.20 9.00±6.00 12.00±6.00	0.004**
Diet with low amount of fruits or vegetables can increase the risk of getting cancer? No I don't know Yes	127(30.5%) 88(21.2%) 201(48.3%)	11.00±7.00 11.00±5.00 12.23±6.00	0.201
Being overweight can increase the risk of getting cancer? No I don't know Yes	156(37.6%) 106(25.5%) 153(36.9%)	11.00±6.00 12.00±5.00 13.00±7.00	< 0.001**
Having a close relative with cancer can increase the risk of getting No I don't know Yes	173(42.0%) 48(11.7%) 191(46.4%)	11.00±6.00 11.00±4.00 12.23±6.00	< 0.001**
Drinking alcohol can increase the risk of getting cancer?	41(9.8%)	10.00±6.00	< 0.001**

No	36(8.6%)	10.00±5.00	
I don't know	340(81.5%)	12.00±6.00	
Yes			
lack of physical activity can increase the risk of getting cancer?			0.001**
No	133(31.8%)	11.00±7.00	
I don't know	100(23.9%)	12.00±5.00	
Yes	185(44.3%)	12.00±6.00	
Sunburn can increase the risk of getting cancer?			< 0.001**
No	153(36.8%)	10.00±7.00	
I don't know	105(25.2%)	12.00±4.00	
Yes	158(38.0%)	14.00±6.00	
Eating too much red or processed meat can increase the risk of getting cancer?			< 0.001**
No	94(22.5%)	10.00±6.00	
I don't know	101(24.2%)	11.00±8.00	
Yes	222(53.2%)	12.00±5.00	
Exposure to another person smoking can increase the risk of getting cancer?			< 0.001**
No	68(16.4%)	10.00±8.00	
I don't know	47(11.3%)	11.00±5.00	
Yes	300(72.3%)	12.00±6.00	
Being older can increase the risk of getting cancer?			< 0.001**
No	171(41.1%)	11.00±7.00	
I don't know	79(19.0%)	11.00±5.00	
Yes	166(39.9%)	12.63±7.00	
Infection with "HPV" Human papilloma virus can increase the risk of getting cancer?			< 0.001**
No	39(9.4%)	10.00±7.00	
I don't know	229(55.0%)	11.00±5.50	
Yes	148(35.6%)	14.00±6.00	
Diet with insufficient amount of fibers can increase the risk of getting cancer?			< 0.001**
No	138(33.0%)	10.73±7.00	
I don't know	142(34.0%)	11.30±5.00	
Yes	138(33.0%)	14.00±7.00	
Early screening for cancer can decrease the risk of dying by cancer?			< 0.001**
No	20(4.8%)	5.00±8.50	
I don't know	19(4.5%)	10.00±5.00	
Yes	379(90.7%)	12.00±5.00	
Hepatitis B virus infection can increase the risk of getting cancer?			< 0.001**
No	51(12.6%)	10.00±7.00	
I don't know	132(32.5%)	11.00±5.50	
Yes	223(54.9%)	12.00±6.00	
What age is most likely to get cancer?			0.088
Twenties	4(1.0%)	10.50±9.50	
Thirties	10(2.4%)	10.00±10.00	

Forties	7(1.7%)	13.00±10.00	
Fifties	13(3.1%)	11.00±5.00	
Sixties	9(2.2%)	16.00±3.00	
Seventies	5(1.2%)	18.00±6.00	
Eighties	26(6.3%)	12.23±6.00	
I don't know	31(7.5%)	12.00±5.00	
Cancer isn't related to age	311(74.8%)	11.73±5.00	
Knowledge about Cancer screening:			
Is there a bowel cancer screening program?			0.006**
No	45(10.8%)	12.00±9.00	
I don't know	216(51.9%)	11.00±5.00	
Yes	155(37.3%)	12.23±6.00	
What is the age for bowel cancer screening?			< 0.001**
25 years old	341(82.8%)	11.27±5.00	
30 years old	18(4.4%)	14.00±7.00	
40 years old	27(6.6%)	13.00±8.00	
45 years old	26(6.3%)	16.00±4.00	
Is there a breast cancer screening program?			< 0.001**
No	8(1.9%)	8.50±8.50	
I don't know	40(9.6%)	10.00±3.79	
Yes	369(88.5%)	12.00±5.00	
What is the Age for breast cancer screening?			0.001**
25 years old	323(77.8%)	11.00±5.00	
30 years old	37(8.9%)	14.00±6.00	
40 years old	39(9.4%)	14.00±7.00	
45 years old	16(3.9%)	14.00±5.00	
Is there a cervical cancer screening program?			< 0.001**
No	25(6.0%)	10.00±10.00	
I don't know	215(51.6%)	11.00±4.00	
Yes	177(42.4%)	14.00±6.00	
What is the age for cervical cancer screening?			< 0.001**
25 years old	69(16.7%)	12.00±7.00	
30 years old	27(6.5%)	14.00±8.00	
40 years old	33(8.0%)	16.00±6.00	
45 years old	23(5.6%)	14.00±7.37	
I don't know	261(63.2%)	11.00±6.00	

^a Interquartile range
^bFisher exact test is used
^cNot applicable
**P value less than 0.01
*P value less than 0.05

Table 6: Univariate analysis for knowledge about cancer risk factors and screening programs against sex,residency and having relative with cancer (N= 418)

Variables	Gender		Having relative with cancer	
	Female(%)	p-value	Yes(%)	p-value
Knowledge about cancer risk factors:				
smoking can increase the risk of getting cancer?		0.070* ^b		0.089 ^b

No I don't know Yes	2(28.6%) 6(85.7%) 255(64.4%)		1(14.3%) 2(33.3%) 203(50.9%)	
Diet with low amount of fruits or vegetables can increase the risk of getting cancer? No I don't know Yes	75(60%) 66(75%) 121(61.7%)	0.052	57(45.6%) 44(50.6%) 104(52.3%)	0.501
Being overweight can increase the risk of getting cancer? No I don't know Yes	87(57.2%) 73(70.2%) 102(67.5%)	0.062	72(47.1%) 53(51%) 81(52.9%)	0.581
Having a close relative with cancer can increase the risk of getting No I don't know Yes	111(65.3%) 22(47.8%) 129(68.6%)	0.030*	79(45.9%) 20(41.7%) 106(56.4%)	0.063
Drinking alcohol can increase the risk of getting cancer? No I don't know Yes	16(40%) 20(55.6%) 226(67.9%)	0.001**	16(40%) 15(42.9%) 174(51.6%)	0.264
lack of physical activity can increase the risk of getting cancer? No I don't know Yes	75(57.7%) 66(67.3%) 122(67%)	0.178	58(44.6%) 48(48.5%) 100(54.3%)	0.225
Sunburn can increase the risk of getting cancer? No I don't know Yes	88(58.3%) 61(60.4%) 113(72.4%)	0.023*	63(41.4%) 54(51.9%) 89(57.4%)	0.018*
Eating too much red or processed meat can increase the risk of getting cancer? No I don't know Yes	56(60.2%) 65(67%) 141(64.4%)	0.615	37(39.8%) 46(46%) 122(55.7%)	0.025*
Exposure to another person smoking can increase the risk of getting cancer? No I don't know Yes	43(65.2%) 29(61.7%) 190(64.6%)	0.918	32(47.1%) 24(52.2%) 150(50.7%)	0.833
Being older can increase the risk of getting cancer? No I don't know Yes	107(64.1%) 50(66.7%) 105(63.3%)	0.876	69(40.8%) 37(46.8%) 99(60.7%)	0.001**
Infection with "HPV" Human papilloma virus can increase the risk of getting cancer? No I don't know	28(73.7%) 138(61.9%)	0.352	12(31.6%) 112(49.6%) 81(55.1%)	0.035*

Yes	96(65.3%)			
Diet with insufficient amount of fibers can increase the risk of getting cancer?		0.026*		0.438
No	75(55.1%)		66(47.8%)	
I don't know	94(67.6%)		76(54.3%)	
Yes	94(69.6%)		64(47.4%)	
Early screening for cancer can decrease the risk of dying by cancer?		0.014*		0.203
No	10(50%)		7(35%)	
I don't know	6(35.3%)		7(36.8%)	
Yes	247(66.2%)		192(51.3%)	
Hepatitis B virus infection can increase the risk of getting cancer?		0.174		0.207
No	31(63.3%)		19(38%)	
I don't know	92(70.8%)		69(52.7%)	
Yes	134(60.9%)		109(49.5%)	
What age is most likely to get cancer?		0.037* ^b		0.293 ^b
Twenties	2(50%)		2(50%)	
Thirties	4(50%)		3(30%)	
Forties	2(28.6%)		3(42.9%)	
Fifties	5(38.5%)		10(76.9%)	
Sixties	4(44.4%)		5(62.5%)	
Seventies	4(80%)		4(80%)	
Eighties	13(50%)		15(48.4%)	
I don't know	21(75%)		16(61.5%)	
Cancer isn't related to age	207(67.2%)		148(48.2%)	
Knowledge about Cancer screening:				
Is there a bowel cancer screening program?		0.716		0.123
No	26(59.1%)		18(42.9%)	
I don't know	139(65.6%)		117(54.7%)	
Yes	98(64.5%)		70(45.2%)	
What is the age for bowel cancer screening?		0.705		0.057
25 years old	213(63.8%)		174(51.8%)	
30 years old	9(52.9%)		6(33.3%)	
40 years old	19(70.4%)		8(29.6%)	
45 years old	17(65.4%)		15(57.7%)	
Is there a breast cancer screening program?		< 0.001**		0.026* ^b
No	1(12.5%)		4(50%)	
I don't know	6(15.8%)		12(30%)	
Yes	256(70.5%)		190(52.2%)	
What is the Age for breast cancer screening?		0.415		0.928
25 years old			157(49.2%)	
30 years old	197(62.5%)		19(52.8%)	
40 years old	26(70.3%)		20(51.3%)	
45 years old	29(74.4%)		9(56.3%)	
	11(68.8%)			
Is there a cervical cancer screening program?		0.001**		0.833
No	16(69.6%)		12(52.2%)	
I don't know	118(55.9%)		109(51.2%)	
Yes	129(73.7%)		85(48.3%)	

What is the age for cervical cancer screening?		0.013*		0.222
25 years old	48(69.6%)		33(47.8%)	
30 years old	17(63%)		13(48.1%)	
40 years old	26(78.8%)		23(69.7%)	
45 years old	20(87%)		11(47.8%)	
I don't know	148(58.5%)		123(48%)	

^a Interquartile range

^b Fisher exact test is used

^c Not applicable

**P value less than 0.01

*P value less than 0.05

Table 7: The table shows multiple regression analysis for socio-demographic factors and health seeking barriers taking knowledge about cancer symptoms as dependent variable (N=418)

Variables	Unstandardized Coefficients		Standardized Coefficients	t	p-value	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	12.082	1.093		11.058	.000	9.934	14.230
Socio-demographic variables:							
Origin	.450	.222	.103	2.029	.043*	.014	.885
Occupation	-.089	.164	-.027	-.541	.588	-.410	.233
Did any of your family get cancer before?	.626	.436	.070	1.438	.151	-.230	1.483
Health seeking barriers (rate your agreement with the following):							
It will be difficult for me to accept the disease and I will be afraid of it	-.005	.212	-.002	-.024	.981	-.423	.412
I will be concerned about the tests they may want to make and their results	.209	.231	.068	.906	.366	-.245	.662
I will be afraid of the complications of cancer treatment	-.101	.208	-.034	-.486	.627	-.510	.308

Health care and infrastructure is Poor in hospitals	-.153	.190	-.052	-.803	.422	-.526	.221
I am not confident in the efficiency of doctors and their non-good dealings with patients	-.143	.199	-.046	-.717	.474	-.534	.249
Preference of municipal remedies over the chemical treatments	-.765	.184	-.217	-4.166	< 0.001 **	-1.126	-.404
I don't want to be a burden on others and the lack of social support	.116	.174	.038	.668	.505	-.226	.459
I had a bad experience with the doctor in the past	-.079	.193	-.022	-.408	.684	-.458	.301
a. Dependent Variable: Knowledge about Symptoms Scale							

*P value less than 0.05

**P value less than 0.01