Economic Burden of Breast Cancer Treatment among Female patients in Addis Ababa, Ethiopia

Thesis

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Referat (English)

This dissertation report presents the results, discussion and conclusions of two interrelated studies that are titled "The health system cost of breast cancer treatment in Addis Ababa" and "Willingness and Ability to Pay for breast cancer treatment in Addis Ababa". The general objective of these two studies is to estimate the economic burden of breast cancer (BC) treatment in Addis Ababa. The specific objective of the first study was to estimate the cost of breast cancer treatment at public health facility- in Tikur Anbessa Specialized Hospital (TASH) Addis Ababa while the second study was to identify WATP of patients for their BC treatment, and the factors that affect their Willingness and Ability To Pay (WATP). Both studies were quantitative and data were collected through interview and from secondary data.

The first study results indicate that to provide complete treatment to a hypothetical BC patient, the health system will incur 536 US dollars (USD) for BC stage I patient and 705 USD for BC stage II or III using the existing infrastructure and all other inputs. These costs, however, will increase to 955 USD for stage I and 1157 USD for stage II and III when infrastructure is improved and inputs are available. The projected total costs of BC treatment will be between 540,000 USD and 1.48 million USD using the existing infrastructure and resources but this amount will increase to 870,000 USD and 2.29 million USD when infrastructure is improved and inputs are available.

The second study result revealed that patients treated at TASH and private health facilities had a median expenditure of 336 USD and 926 USD respectively. The median amount that patients were WATP was 50 USD at TASH and 149 USD in private health facilities. The study found that WATP of patients increases with increasing expenditure (OR 1.44; 95% CI 1.10 to 1.90 per 100 US), educational level (OR 1.37; 95% CI 1.02 to 1.84) and service quality (OR 1.33; 95% CI 1.03 to 1.71). In contrast, a monthly income increase by 100 USD corresponds to a 17 % decrease of WATP (OR 0.83; 95% CI 0.70 to 0.99).

The conclusion of both studies was the cost of BC treatment was not affordable for both the health system and patients. Thus, to reduce this economic burden, it is recommended to include breast cancer treatment in community and/or social health insurance.

Tamiru Demeke Eshetu: Economic Burden of Females' Breast Cancer Treatment in Addis Ababa, Ethiopia, Halle (Saale), Univ., Med. Fak., Diss., 23 pages, 2024.

Referat (Deutsch)

Diese kumulative Dissertation beschreibt und diskutiert die Ergebnisse zweier miteinander verbundener Studien. Das Ziel der Studien besteht darin, die wirtschaftliche Belastung durch die Brustkrebsbehandlung in Addis Abeba abzuschätzen. Die erste Studie sollte die Kosten der Brustkrebsbehandlung in einer öffentlichen Gesundheitseinrichtung in Addis Abeba schätzen, während die zweite Studie die Zahlungsmöglichkeit und Bereitschaft (WATP) der Patientinnen sowie beeinflussende Faktoren ermittelte. Beide Studien erfolgten quantitativ und basieren auf Sekundärdaten und Fragebögen.

Die Ergebnisse der ersten Studie zeigen, dass das Gesundheitssystem für die vollständige Behandlung einer hypothetischen Brustkrebs-Patientin 536 US-Dollar (USD) im Stadium I und 705 USD im Stadium II/ III aufwenden muss, wenn die vorhandene Infrastruktur genutzt wird. Bei verbesserter Infrastruktur steigen diese Kosten auf 955 USD für das Stadium I und 1157 USD für die Stadien II/III. Die prognostizierten Gesamtkosten der Behandlung liegen zwischen 540.000 und 1,48 Mio. USD, und steigen bei verbesserter Infrastruktur auf 870.000 bis 2,29 Mio. USD.

Die zweite Studie zeigte, dass die Patientinnen, die im öffentlichen und privaten Gesundheitseinrichtungen behandelt wurden, mediane 336 USD bzw. 926 USD ausgaben, während ihre medianer WATP-Betrag bei 50 USD bzw. 149 USD lag. Die WATP der Patienten erhöhte sich mit steigenden Kosten (Odds Ratio [OR] 1,44; 95 % Konfidenzintervall [KI] 1,10 bis 1,90 pro 100 USD), dem Bildungsniveau (OR 1,37; 95 % KI 1,02 bis 1,84) und der Qualität der Dienstleistungen (OR 1,33; 95 % KI 1,03 bis 1,71). Eine Erhöhung des Monatseinkommens um 100 USD führte zu einem Rückgang der WATP um 17 % (OR 0,83; 95 % KI 0,70 bis 0,99).

Zusammenfassend wurde deutlich, dass die Kosten der Brustkrebsbehandlung sowohl für das Gesundheitssystem als auch für die Patienten nicht tragbar sind. Um diese wirtschaftliche Belastung zu verringern, wird empfohlen, die Brustkrebsbehandlung in die gemeinschaftliche und/oder soziale Krankenversicherung aufzunehmen. Die Kosten für die Behandlung von Brustkrebs werden sich auf 870.000 USD und 2,29 Millionen USD erhöhen, wenn die Infrastruktur verbessert wird und die Mittel zur Verfügung stehen.

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Abbreviations and Acronyms

AAPBCR	Addis Ababa Population Based Cancer Registry
AOR	Adjusted Odds Ratio
ATP	Ability to Pay
BC	Breast Cancer
CI	Confidence Interval
CSA	Central Statistics Agency
CTP	Capacity to Pay
OR	Odds Ratio
IQR	Inter Quartile Range
IRB	Institutional Review Board
OOP	Out Of Pocket
OR	Odds Ratio
PCC	Public Cancer Center
PHFs	Private Health Facilities
SPH	School of Public Health
SSA	Sub-Saharan Africa countries
TASH	Tikur Anbessa Specialized Hospital
UI	Uncertainty Intervals
USD	US Dollars
WATP	Willingness and Ability To Pay
WHO	World Health Organization
WTP:	Willingness To Pay

1. Introduction and objectives

1.1 Description of the problem

Breast cancer (BC) is a global health concern that mostly affects women that accounts 24.5% of all types of cancers new cases and 15.5% of deaths from all types of cancers among females. In sub-Saharan Africa (SSA), BC is the leading malignancy in females and becomes a public health issue. As of the year 2020, in Africa, the world age standardized incidence and death rate of BC was about 41% and 19% respectively (1). Another study also estimated that in Africa BC new cases in 2020 was 186,598 [173,041 – 201,217, 95% uncertainty intervals (UIs)] and deaths were 85,787 [77,648 – 94,779, 95% UIs] and these figures will be doubled in 2040(2). Weak health infrastructure including low funding for the health sector and presentation at late stage played paramount role for high death rate and low survival rate respectively (3). This indicates that unless prompt and sustainable actions are taken to reduce the incidence and mortality rate of BC, the disease burden will become a developmental problem for African countries because it will have great economic impact at household and national levels. Thus, the rising incidence and death rates of BC particularly in SSA deserves special attention to address the economic and developmental problems due to BC.

In Ethiopia, likewise in other SSA countries, female BC is the second leading cause of women next to cervical cancer (4). According global cancer report, in Ethiopia, it was estimated that in 2020, the age standardized females' BC incidence and death rates were about 42. and 24 per 100, 000 respectively (1). The BC cases have been increased from time to time. For instance, in 2012 the number of female BC patients who were diagnosed were near to 13,000 but in 2020 this number roused to 16, 133(1) which means the prevalence was 48.52 per 100,000. But this figure was higher than the prevalence of BC in Somalia a (31.61/100,000) and South Sudan (25.72/100,000) but lower than Eritrea (48.73/100,000), Uganda (55.46/100,000), Sudan (55.62/100,000), Kenya (57.28/100,000), Nigeria (59.31/100,000), Djibouti (74.71/100,000) and South Africa (138.90/100,000). Furthermore, data disclosed that BC accounts about 32% of the new cases all cancers and 18% of deaths of due to all cancers (1).

The Addis Ababa Population Based Cancer Registry data base indicated that among those female BC patients who came to Tikur Anbessa Specialized Hospital (TASH), most of them were at the reproductive age and at advanced stage. A study that assessed the

reasons for late diagnosis of breast cancer revealed various findings such as misconceptions about the disease due to low awareness of BC because they never heard of BC before they sought treatment for their illness, disregarding or misattribution of BC symptoms, attributing BC to non-cancer illness- sun stroke, locally known as "mitch, misperceptions about conventional BC treatment and its outcomes, and non-medical management of BC symptoms such as performing spiritual acts (mainly using holy water) or seeking care from traditional healers.

treating the disease using traditional medicine, preferred traditional healers and lack of finance for treatment. Nonetheless, they did not get immediate treatment in that they were given long time appointment. As a result of this, their BC reached at higher stage which made the treatment outcome unsuccessful for many of them (4).

However, some of the patients were compelled to go to private health facilities to get treatment in short time where the treatment cost is much higher than the above-mentioned public health facility. In order to cover the cost of treatment, patients and their family members were compelled to sell their valuable properties, and then ask donation from their relatives and friends. Finally, the patient and the household get into deeper poverty. This clearly shows the extent of the economic burden of BC treatment. Therefore, BC is not only a large health burden but also it has a significant economic burden to society. However, economic burden of BC from both sides is not well documented and it is apparent that it must be measured from the health system and patient sides.

As mentioned above, TASH provide breast cancer treatment and it was the only hospital that provided cancer treatment to all people of the country until recent time. However, the hospital does not know how much the hospital incur to treat a breast cancer at each stage of the disease. On the other hand, both TASH and private hospitals charge patients for breast cancer treatment and diagnosis but neither TASH nor private hospitals fixed their based on the willingness and ability to pay breast cancer treatment.

These are because, to the best of our knowledge, no study particularly in Ethiopia has been conducted on the health system cost of breast cancer treatment and the willingness and ability to pay for breast cancer treatment.

1.2 Research objective

The overall objective of this doctoral dissertation was to estimate the economic burden of BC treatment at system and patient level. Under this objective, two independent but

interrelated studies titled “Health system cost of breast cancer treatment in Addis Ababa, Ethiopia” and “Willingness and ability to pay for breast cancer treatment among patients from Addis Ababa, Ethiopia: A cross-sectional study” were conducted.

The conceptual framework of this dissertation was explained as the economic burden of BC is the sum of the total direct, indirect and intangible costs that both the health system and patients incur for the treatment breast cancer. For the above-mentioned studies, however, only the direct costs of treatment that the health system and patients incurred were considered.

The objective of the first study “Health system cost of breast cancer treatment in Addis Ababa, Ethiopia” was to estimate the cost of BC treatment that the health system will incur to provide standard and complete treatment to a hypothetical breast cancer patient stage I, II, and III. The specific objectives this study were (a) estimate the unit cost of breast cancer treatment to provide standard and complete treatment to a hypothetical patient stage I, II and III using the existing infrastructure, human resources and inputs and assuming if the existing infrastructure is improved, the necessary human resource are deployed and other missed medical and non-medical inputs are availed, (b) identify the cost drivers of BC, (c) project the total cost of breast cancer treatment for the next five years in the aforementioned two scenarios, and (d) estimate the economic burden of the disease on the health system specifically on TASH based on the aforementioned two scenarios.

The objective of the second study “Willingness and ability to pay for breast cancer treatment among patients from Addis Ababa, Ethiopia: A cross-sectional study” was to identify the economic burden of breast cancer treatment among patients and their household. The specific objectives of this study were (a) how much BC patients and/or their families actually paid for treatment of BC and (b) how much they were willing and able to pay for BC treatment.

Apart from the above-mentioned objectives, the studies have the following significances:

i. They fill the knowledge gap that exists with respect to the economic burden of breast cancer treatment at Ethiopia level in particular and Africa at large
ii. The findings of the studies are useful for planning, budgeting and resource mobilization for BC treatment
iii. The studies provide useful evidence to policy makers regarding the costs of BC treatment at health system and patient levels and they will make decision.

iv. Finally, the findings of the studies can help healthcare providers to choose best treatment options at lower cost.

2. Discussion

The studies titled "Health system cost of breast cancer treatment in Addis Ababa, Ethiopia" and "Willingness and ability to pay for breast cancer treatment among patients from Addis Ababa, Ethiopia: a cross-sectional study" are the first studies in Ethiopia that tried to estimate the economic burden of BC treatment from health care system and BC patients' perspectives. Economic burden studies are conducted by converting disease related burdens into economic and monetary values to measure socio-economic costs unavoidably incurred by both the health care system and patients for the specific disease which is under consideration and to assess the economic burden that the disease imposed at household and national level from the patients and government sides (5). The economic burden of disease includes direct economic burden, indirect economic burden, and intangible burden. The direct economic burden refers to the economic resources directly consumed to prevent and cure disease. We define the medical expense of hospitalization as a direct financial burden. Our studies focused on direct economic burden only. All these burdens significantly affect both the health system as the government cannot allocate sufficient budget to provide treatment and patients and their families will be compelled to use their income and saving first and will sell their properties that they bought after a long-time effort. Eventually, both the nation and patients will fall into poverty trap from which they may not escape.

With this background and basic concept of economic burden of diseases including breast cancer, the results of the two studies are discussed as follows.

2.1 Health system cost of breast cancer treatment in Addis Ababa, Ethiopia (publication one)

Health system cost studies, irrespective of the disease type they address, are valuable tools for understanding the economic burden of the disease under investigation on a nation and supporting policymakers in allocating health resources.

Prior to estimating the unit and total cost of BC treatment to see the economic burden at national level, we tried to calculate the actual costs that TASH incurred to provide treat BC patients.

To do this, we reviewed the medical charts of all Addis Ababa resident patients but we found 52 patients only who completed their treatments. From these medical charts, we

collected the types of diagnosis and treatments provided to the patients and we collected the costs that TASH incurred to buy all the necessary medical reagents, drugs and supplies from various department of TASH. While computing the total costs of BC treatment, we considered the direct medical and non-medical costs only that TASH incurred for the provision of breast cancer treatment were considered. However, those costs that were incurred for treatment of comorbidities were not included in this study.

To achieve reliability and transparency in cost estimation, a bottom-up approach was used, where each service component was identified and valued at the most exhaustive level. The cost for each service was obtained by multiplying its unit cost with number of times it was provided. The total cost estimated for each patient was calculated by summing the cost of all services used.

After the completion of computing the actual costs of treatment, we found that the total of BC treatment was USD 33,261 to treat 52 female BC patients in TASH between July 2017 and June 2019. This means TASH incurred on average about USD 640 per patient. While conducting the study, we collected data how much money each patient paid for each type of healthcare service. We found that the amounts that patients paid were much lower than the actual costs that TASH incurred. To confirm this, we interviewed both health and non-health professionals and they explained that the healthcare service fees that the patients paid did not cover the costs that TASH incurred. This shows that breast cancer treatment like other diseases treatment was highly subsidized by the government. The implication of this finding is that as the number of BC patients increased, the budget that the government should allocate to subsidize BC treatment also increased. Since government has limited financial resource, the budget allocated for TASH was not sufficient budget to provide all prescribed healthcare services to BC patients even if the health professionals were ready and had the capacity to provide the treatment. For this reason, it is customary to see that patients were forced to get some types of diagnosis services and to buy drugs outside TASH with high costs. This indicates that insufficiency of the budget allocated to TASH exposed BC patients to unexpected and unwanted catastrophic health expenditure. This is one way that shows the economic burden of BC treatment on the health system.

In addition to estimating the economic burden of BC treatment on the health system based on the actual cost incurred by TASH as discussed above, we tried to estimate the

economic burden of BC treatment based on the standard treatment as recommended by the oncologists and breast cancer treatment guideline.

While estimating the health system cost of BC treatment, various health and non-health professionals were involved by providing responses for the questions they were asked using questionnaire prepared for this purpose. Moreover, various official and non-official reports and records of TASH as well as other pertinent organizations' reports and records were reviewed.

Accordingly, we found that the unit cost of treatment for a hypothetical BC patient to complete her treatment was USD 536 for stage I and USD 705 for stage II and III using the existing infrastructure. This cost increased to USD 955 for stage I and USD 1157 for stage II and III when infrastructure amortization was considered. The projected total costs of BC treatment in TASH are between USD 540,000 and USD 1.48million. However, this will increase to USD 870,000 and USD 2.29 million when the existing fixed assets are changed.

All in all, the treatment of patients with stage I BC accounted for 6% of the overall cost incurred, whereas stage II and stage III patients accounted for 26% and 61% of the total cost.

This study found significant variations in the costs associated with the optimal treatment for people with BC. The most expensive treatment was chemotherapy, which was followed by radiotherapy and consulting fees. According to the current treatment protocols at TASH, this study discovered that the overall expenditures of treating BC increased dramatically with advanced disease stages. In comparison to BC patients with stage I, individuals with stages II and III required more costly treatment.

This result is similar with the finding of Guzha et al. that reported out of the total cost of BC treatment 6%, 47% and 35% of costs were incurred for treating stage I, II and III BC respectively, though these costs were paid by the patients(6). On the other hand, Nguyen et al.'s study revealed that the initial cost of treating BC was only USD 128.7 for stage I, USD 684.1 for stage III, but the cost was dropped by more than 21 percent for stage IV. Additionally, this study found that TASH spent USD 11,704 on chemotherapy which was USD 180.66 per patient.

In all cases, a significant portion of the overall cost of treating BC was incurred for consumable materials. The cost share of building renovation would be higher than the

cost share of human resources if maintenance expenditures, such as those associated with renovating existing buildings, were taken into account. The advanced stages of BC were more expensive than the earlier stages when it came to the costs of consumable inputs. Due to variations in imaging use and low-cost radiation, the costs of BC treatment as per the NCCN recommendation for SSA were somewhat higher than those according to current practice.

Furthermore, costs for all new BC patients, who will present at TASH for treatment during the next five years were projected. The number of patients in need of treatment undoubtedly affects the total cost. According to the Addis Ababa Population Based Cancer Registry (AAPBCR) and Central Statistics Agency (CSA) data, there was a projected rise in the number of new cases of BC. This projection might even be an underestimate, because with expected higher awareness, the number of Addis Ababa residents, who demand BC treatment may increase. The money to be allotted would need to increase to USD 1.5 million in 2025 due to the annual increase in the number of patients with BC. This is a result of rising investment prices for recently purchased furniture and medical and non-medical equipment, as well as rising building renovation expenditures (which have increased by an average of 144%). Because of this, the estimated and projected total cost of BC treatment will be 1.02% and 1.251% of the total health budget in 2021 and 2025 respectively. Due to this, TASH will have to mobilize funds from both local and international sources. According to the projection, the total treatment cost will increase from USD 568.6 for stage I to USD 901.8 for stage II; however, the treatment cost fell to USD 816.1 and USD 603.4 for stages III and IV, respectively. This decline was caused by the comparatively easy follow-up care for BC in the years following the initial treatment(7).

As the majority of patients had treatment for advanced stages, it is evident that the expenses per patient rose as the stages expanded.

According to those studies, which were carried out at Groote Schuur Hospital in Cape Town, South Africa, and TASH in Addis Ababa, Ethiopia, patients paid, on average, significantly more for chemotherapy—USD 1,489 and USD 1,188, respectively(6). According to research done in Morocco on the cost of various medication units, cycle-specific protocol costs, and individual treatment costs, the unit cost of chemotherapy medications, such as cyclophosphamide (1000 mg), was USD 7.28. Additionally, the entire cost of the chemotherapy treatment was USD 84.50 for AC, USD 1,105 for

Docetaxel, and USD 1560 for Trastuzumab(8). Chemotherapy treatments in Vietnam typically cost USD 476.48 (7). This demonstrates that, in Addis Ababa, the expense of chemotherapy was quite modest as compared to other contexts where more contemporary drugs are employed.

There have also been reports of high treatment expenses for BC from other nations. According to Saber Boutayeb et al., a patient with BC may have to pay anything from USD 507 to USD 30,088 for chemotherapy. Vietnam also had treatment costs of USD 632.86 for the first treatment and USD 975.01 for the entire 5-year course of treatment, respectively(7). A recommendation was made to the Morocco government to allocate annually for BC treatment between USD 13.3 million to USD 28.6 million (8). According to these researches, knowing the entire cost of BC treatment is essential since it will help those making financial decisions about the treatment.

To summarize, this study indicates that the cost of treating new patients with BC is determined by several factors, including the total amount of patients treated, the percentage of patients in an advanced stage, and the specific choice of expensive targeted therapies like trastuzumab. It is important to highlight that early BC detection and treatment should be highly prioritized in order to significantly lower the cost of BC treatment and raise survival rates (9, 10). Therefore, it is recommended that when planning and budgeting for BC prevention and treatment, the Ministries of Finance and Health of Ethiopia as well as TASH utilize the data and conclusions of this study as a baseline. Furthermore, the data from this study can be utilized as a resource to generate budgetary suggestions for the various components of BC treatment from the standpoint of public health.

The findings of the health system cost of BC study revealed that BC treatment requires allocation of huge budget that in turn has heavy economic impact on the country.

The conclusion of this study was that the economic burden of BC treatment was high compared to the economic status of the country and it was recommended that TASH should revise its charges and BC should be included in the Social and Community based health insurance scheme (see publication 1)

2.2 Willingness and ability to pay for breast cancer treatment among patients from Addis Ababa, Ethiopia: a cross-sectional study (publication two)

Willingness and ability to pay is the other name of demand in that people buy a good or service as long as they have willing and financial ability to pay for it. The demand for health care service is also expressed in terms of the willingness and ability to pay of a patient for the health care service that he or she seeks(11). But the demand for health care services is not the same as the demand for other kinds of goods and services; rather, people are content with their lives when they are well, thus they do not feel the need for health care. Thus, the demand for health care service is a derived demand for health care. Thus, health economists make a distinction between demand and need. Demand is determined by their preference supported by financial resources, whereas need is determined by one's capacity to get health care. (12). Therefore, examining the ability and willingness to pay for medical care is equivalent to examining the demand from consumers for these services.

"Willingness and ability to pay for breast cancer treatment among patients from Addis Ababa, Ethiopia: a cross-sectional study" was the second study that tried to assess the WATP for BC treatment among BC patients in Addis Ababa. The study participants were Addis Ababa residents who presented in TASH and other selected three private health facilities for treatment. Structure questionnaire was prepared first in English and then translated to Amharic language and then pre-tested in other hospital where BC treatment is given but not included in the study. Oncology nurses were hired and trained for data collection. Interviews were conducted with each patient after the consent statements were read properly and getting their oral consent.

The aims of this study were to assess how much money BC patients spent for their medical treatment and how much money patients are willing and able to pay for BC treatment in Addis Ababa, Ethiopia. In other words, as explained above, this study aimed to assess the demand for breast cancer treatment among Addis Ababa resident BC patients.

The study participants were interviewed, of course after getting their oral consent, and the collected data were analyzed using SPSS version 26, STATA version 15 and the Statsmodels library version 0.14.0 in Python.

This study found that patients' median expenditure for all BC treatment services was 336 US dollars (USD) in a public cancer center and 926 USD in privately owned health facilities.

Those patients who were treated upto two years paid higher amount (505 USD) as compared to the amount (454 USD) that those patients who were treated for more than two years paid.

This study further found that costs of BC treatment were considerably, in general high, at private health facilities (PHF) and it was three times fold as compared to the costs that Tikur Anbessa Specialized Hospital-Radiation Centre (PCC) charged.

The majority of respondents who received care in private medical facilities complained that the actual amount that they paid for their treatment was expensive. As a result, this study found that, 56% of interviewed patients as well as their families were exposed to catastrophic health expenditure and financial distress. Due to the life-threatening nature of the disease, however, patients were forced to sell their valuable properties. In addition, they had to borrow money and ask friends and family for financial support to cover the cost of treatment after their savings ran out. This shows that the economic burden of breast cancer treatment was too high for both the patients and their families.

With regard to WATP, those patients who were treated at PCC were willing and ablt to pay median amount of 50 USD (IQR 19 to 134) and while those patients who were treated in private health facilities were willing and able to pay a median amount 149 USD (IQR 66 to 383) for all healthcare services. This study tries to assess the WATP of patients for each type of healthcare service and it found that patients treated at PCC were willing and able to pay a median amount of 13 USD (IQR 2.5 to 37.27) for surgery, 13 USD (IQR 0.0 to 25.27) for chemotherapy and 13 USD (IQR 1.3 to 25.27) for inpatient service. However, those patients who were treated in PHFs were willing and able to pay a median amount f 253 USD (IQR 253 to 379) for surgery and 35 USD (IQR 23 to 76) for drugs.

Also, those patients who were treated for upto two years were willing and able to pay higher median amount (71 USD) as compared to the median amount (27 USD) that those patients who were treated for more than two years.

The multivariable regression results showed that the amount that patients are willing and able to pay is affected by the prevailing consumption trend which is expressed in terms

of consumption expenditures other than expenditures incurred for breast cancer treatment, service quality and monthly income that the patients and their families have.

Accordingly, as total expenditure of the patients and/or their families increased by 100 USD (OR 1.44; 95% CI 1.10 to 1.90 per 100 US), patients' educational level increase (OR 1.37; 95% CI 1.02 to 1.84) and service quality is increased (OR 1.33; 95% CI 1.03 to 1.71), patients WATP will increase.

In contrast to the above finding, as the monthly income of the patients and/or their families increased by 100 USD, their WATP to breast cancer will be decreased by 17 % (OR 0.83; 95% CI 0.70 to 0.99).

When we compare the actual amount that patients paid at both PCC and PHF for all health care services with their WATP in the aforementioned health facilities, it was found that the median amounts that patients eventually paid for all services both at PCC and PHFs were six times higher than the median amounts that patients are willing and able to pay in both types of health facilities. This indicates that these patients were forced to pay a higher amount for treatment beyond the amount they were willing and able to pay because BC is a life-threatening disease and they want to survive at any cost. This further indicates that the actual amount that patient paid at the time of treatment did not reflect their demand for BC treatment in that demand is, by definition(11), "WATP to buy a good or service" which includes health care services. The study revealed that the actual cost is more than what patients are willing and able to pay and more than their demand for health care services. This apparent contradiction is likely due to the perceived threat or severity of diseases(13, 14) that patients had pushed them to pay more beyond their WATP or it is usual and widely acknowledged that there is differences between preferences that patients express during interview and what they actually pay during treatment (15) or poorer report concerning what patients remember having spent in the past.

Various studies conducted in different countries also revealed similar results. For example, a study conducted in Nigeria indicated that out of the total number of respondents, 95 percent of them were obliged to expend 10 percent of their annual income while 86 percent of the interviewed patients were obliged to expend 25 percent of their annual income for breast cancer treatment. This study further revealed that 90 percent of respondents were exposed for catastrophic health expenditure when their expenditure was evaluated based on their household´s capacity-to-pay(16). A study conducted in, Western

and Northern part of Ethiopia also indicated that about 23% and 64% patients were exposed to catastrophic health expenditure due to direct medical costs respectively, though the participants in those studies were not cancer patients (17, 18). According to a study that assessed the prices of health care in 15 African countries, including Ethiopia, patients were compelled to sell their fixed and precious assets and to borrow to cover their health care expenditures. A study conducted in Ghana also indicated that among breast cancer patients who were treated in tertiary hospital, most of the patients were obliged to incur expenditure for their treatment more than their income and as a result of this they were forced to sell their financial assets as well as borrow money from their relatives and friends(19). The results that this and other studies found were consistent with the argument that says WTP and ATP are not the same and cannot be used interchangeably since health care costs have the potential to significantly impact household investment and consumption habits as well as initiate a process of asset depletion and improvement. Moreover, a high proportion of patients were not able to get health care services, because they could not afford the costs (20, 21). Other patients paid 2,325 USD in Addis Ababa for cancer treatment (22), but 600 USD in Uganda and 2100 USD in Nigeria(23) . Our finding is also consistent with the theoretical definition of catastrophic health care because the following factors are met: (24) the cost of health care service is covered OOP, (24) the household capacity to pay (CTP) is low, and (24) there is no prepayment system for risk mitigation (25). WHO also declared that a household is said to be exposed to catastrophic health expenditure if the OOP expenditure on health is greater than or equal to 40% of the household's CTP (26). In other words, the health expenditure is considered catastrophic if it is above the financial means of the household and this will lead the household to poverty or prevent the household from getting out of poverty. As indicated in the present study, most of the patients were exposed to catastrophic health expenditure because they incurred costs beyond their CTP. This shows that even though Ethiopian patients are in a lower economic category than patients in other countries, they spent similar amounts of money for their BC treatment. This underlines the high economic burden of BC on Ethiopian patients.

Patients estimated their personal WATP but eventually retrieved funding from a much larger extended family. Most of the patients were housewives who were financially dependent on income from their husbands, children, and relatives. The payments made for BC treatment created financial distress not just on the patient only but on their

extended families as well. Therefore, it may not always be assumed that a patient's expression of a WTP for a service, even if the patient goes on to pay for it in person, is evidence of affordability. Payments may be made at significant social costs, forcing the patient to forgo necessities like schooling in order to obtain the service (27). A study conducted in Nigeria also revealed that about 78% of study participants with BC were not able to get treatment because of financial barriers they faced(28) and research conducted in Iran indicated that due to the cost of cancer treatment, patients' and their families' living conditions were worsened (25).

We observed that patients paid more at PHFs compared with PCC for similar treatment because PHFs are profit making institutions and provide treatment more quickly than PCC. For instance, a study conducted at PCC, Addis Ababa, Ethiopia and Yaoundé General Hospital, Cameroon revealed that patients with BC had long waiting times between their first consultation and surgery or other treatments (29, 30). In order to avoid treatment delays and to reduce the chance of the cancer progressing during the wait, patients preferred to pay more (31).

Various studies found that WATP can be influenced by factors such as age, education, income, dependency ratio/household size, attitude towards treatment, quality of health care services, locality rural/urban, and ability to pay (32). In our study, we stated an association between average monthly income, education, service quality, and total expenditure and WATP of BC patients.

Increasing income was associated with decreased WATP. This finding was contrary to other studies that dealt with the WTP for BC treatment and other types of cancers because these studies focused on WTP only while our study focused on WATP (33-35). Thus, we found that with increasing income, patients were more able but less willing to contribute to a higher amount of treatment costs. This result is consistent with studies conducted in Bangladesh, Sweden, and Ethiopia had found that the impact of income on WTP for medical care was negligible (36-39).

Educational level is a predictor of WATP. Studies showed that patients with higher educational level have better health literacy, resulting in them being better informed about the treatment and disease and more likely to be willing and able to pay for BC treatment (40-42).

Patients' satisfaction with treatment indicates the quality of the services received by them and influences their WATP (43, 44). Similarly, as BC patients perceived that the treatment, they obtained is good, this implies the quality of the treatment was good and this encourages them to be willing to pay more(45). Our study also showed that those BC patients who were satisfied with the quality of the service they received were WATP. Especially economically better-off patients were WATP more for services that they believed were good. This is consistent with other studies that reported, patients who obtained good quality health care service were willing to pay more (46).

The WATP of those patients who were treated for up to two years was higher as compared to the WATP of those patients who were treated for more than two years. This is due to the fact, as the time of treatment is elongated, patients' paying capacity will be declined and also their hope for being cured is declined. Therefore, these patients will not be willing and able to pay their treatment.

The other factor that was associated with WATP was the total expenditure that patients expend for their consumptions because such expenditure is related to disposable income that the patients and their families have. In other words, a patient's expenditure indicates the level of his/her income. Thus, it is plausible to infer that a patient whose expenditure is high, he/she has more WATP. Our study also found similar result and indicated total expenditure was associated with WATP. This is because expenditure was directly related to income. Those patients who reported higher total expenditure were willing and able to pay more. This finding is consistent with the economic theory that a person's decision is a sequential process where the decision of whether to consume a particular commodity is followed by the choice of how much to consume. As health is a commodity and private good, this economic theory is also applicable to health care service, as we did in our study (47, 48).

The conclusion and recommendation of this study was that BC treatment was very expensive for patients, and the cost was much higher than their WATP. Thus, it was suggested that BC should be included in both social and community-based health insurance plans and treatment fees should consider patients' WATP (see publication 2).

2.3 Strengths and Limitations of the studies

The health system cost and WATP for BC treatment are the first study not only in Ethiopia but also in Africa though there are few studies that focused on WATP for health insurance. These studies like other studies have their own strengths and weaknesses.

Strengths

The health system cost research made an effort to include all of the inputs needed for BC treatment; as a result, it displays the costs associated with providing BC treatment at the individual and city level or in economics terms at micro and macro levels for each stage of the disease. Another feature is that it offers data as a starting point for more investigation and planning. Its third strength is that it shows the system charges a fee for treatment, which is insufficient to pay for the expenses associated with providing BC treatment.

Furthermore, the WATP study has two main strengths. The first strength is that it shows the fee required of public health facilities is excessively lower than the patients' WATP, while the fee required of private health facilities is higher. There has never been research conducted in this way, particularly by including private healthcare facilities. Secondly, it provides first information regarding BC patients' WATP for medical treatment of BC.

Limitations

One of the primary limitations of the health system cost research is its exclusive focus on treatment provided at a tertiary hospital. To ensure that the patients receive the most benefit possible, we deliberately choose for a guideline-concordant strategy. The study excluded the costs associated with treating patients with stage IV BC, treating side effects from medication, and paying for inpatient care for patients with BC. Due to personalized approaches and personal preferences, this could result in a significant degree of fluctuation and increased costs. Another limitation is that the costs it estimates could fluctuate due to inflation, pandemics, or procurement challenges.

The WATP study also has certain limitations of its own. The first limitation is that patients' BC stages were not included in the study because, in most cases, patients were not aware of their disease's stage and because staging may have altered while they were receiving treatment. As a result, we simply made a distinction between patients whose treatment had lasted up to two years and those whose treatment had lasted more than two

years, without taking into account the precise stages of BC of the patients we questioned. The second limitation of the WATP study was the high degree of uncertainty in the responses on the real household income, as income might fluctuate significantly over time and it was challenging for the respondents to estimate an average. Furthermore, responses included both closer and farther relatives, and participant definitions of the home differed. The third limitation was that we presumed that the group of relatives who contributed financially to WATP were likely seen as relatively similar by respondents, given that the interquartile range of WATP only varied by five times.

2.4. Conclusions and Recommendations

2.4.1 Conclusion

The two studies in general indicate that the cost of BC treatment has resulted high economic burden at patients as well as their household and health system level. This is mainly due to low paying capacity of patients and the low economic level of the country in other words due to low economic status at all levels.

According to the health system cost study, the presence of patients in advanced stages made the cost of treatment high as compared to the cost incurred for treatment of stage I BC. In terms of service, radiation treatment and surgery were found costly. The projection of cost of treatment also indicated that the periodic increase in the number of BC patients in need of treatment all contributed to the health system's rising costs. In general, the cost of breast cancer treatment was too high and required significant amount of budget. The health system was financially strained as a result of all these problems.

The WATP survey also unequivocally demonstrated that, despite these healthcare facilities' excellent reputation for quick treatment delivery, the majority of BC patients could not afford the treatment costs at these private facilities. However, TASH charged too little for treatment, and patients had to wait a long period, which made their condition worse. Those who needed treatment quickly therefore resorted to private hospitals, but due to their low paying capacity, the BC treatment exposed these patients to catastrophic health expenditure. Conversely, patients from poorer socioeconomic backgrounds visited TASH, but they had to wait a long time for treatment, and by the time they did, their BC stage had advanced. As a result, many of the respondents were forced to ask financial support from their friends and relatives, and to sell their high value properties. This indicates that the economic burden of BC at household level was too high. The WATP of

patients for their treatment was much lower than the actual amount they paid in private health facilities but higher than the amount that they actually paid at TASH.

2.4.2 Recommendations

The research' overall conclusion is that community-based and social health insurances should cover BC treatment in order to reduce the cost of the treatment for both patients and the system. Patients will be able to receive the necessary treatment without worrying about running out of money thanks to these insurances, which will also allow the health system to continue providing care without running out of resources. As part of the nation's efforts to achieve universal health coverage, tertiary hospitals should adjust its fees at the system level so that it can at least cover the cost of treating patients. To make this a reality, the hospital should support the inclusion of BC in community-based and social health insurance plans. Tertiary hospitals should also work with pharmaceutical companies and development partners to negotiate better prices for pricey medical supplies and equipment. This will help to lower the cost of BC treatment for all women who wish to receive it and lessen the financial burden of BC treatment on the health system.

BC treatment shouldn't be so expensive or catastrophic for patients that it lowers their standard of living for them and their family. Consequently, in order to alleviate the financial burden of BC treatment at the patient level, private healthcare facilities should develop measures to keep rates reasonable for their patients.

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4. Theses

1. Tikur Anbessa Specialized Hospital incurred a total of USD 33,261 (USD 1855, 8,221, 19,558, and 3,626 for Stage I, II, III and IV respectively) for provision of full treatment for 52 breast cancer (BC) patients.

2. The unit cost of BC treatment was USD 536 for stage I and USD 705 for stage II/ III based on the current practice, infrastructures and existing human resources. These costs will be increased to USD 955 for stage I and USD 1,157 for stage II/III if the existing infrastructures are replaced or renovated.

3. To treat projected new BC patients, using the existing infrastructure, TASH will need USD 590,000 in 2021 to USD 1.41 million in 2025 if the annual inflation is 20 percent. These amounts will increase to USD 950,000 in 2021 and USD 2.29 million in 2025 if existing infrastructure is replaced or renovated.

4. The economic burden of BC treatment at national level will be 0.042% and 0.1% of the total health budget of 2021 and 2025 respectively using the existing infrastructure and assuming 20% inflation rate. If the existing infrastructure is replaced or renovated, the above-mentioned percentages will increase to 0.105% in 2021 and 0.162 in 2025.

5. The WATP study indicated that BC treatment at private health care facilities (PHFs) was very expensive and as a result of this patients and their families had difficulty to obtain money for treatment and were exposed to catastrophic health expenditure as well as financial distress.

6. Those BC patients who were treated at PCC were willing and able to pay a median amount of USD50 (IQR 19 to 134) while those patients treated at PHFs were willing and able to pay a median amount USD149 (IQR 66 to 383) for all health care services.

7. In general, both the health system cost estimation study and WATP study indicated that the cost of BC treatment imposes significant economic burden on both at national level and at household level.

8. WATP was associated with Ex-marriage, monthly income, total expenditures of patients, educational level and service quality of BC treatment.

9. As women became Ex-married (divorced or widowed) their WATP was much lower as compared to married women.

10. As total expenditures of patients and educational levels increased as well as service quality becomes good, patients' WATP for BC treatment will increase.

Publications

This thesis is based on the following two articles published in international peer reviewed journals, and the contribution to each of the studies is stated.

Publication one: **Tamiru Demeke**, Wondimu Ayele, Damen Haile Mariam, Andreas Wienke, Mathewos Assefa, Adamu Addissie, Rafael Mikolajczyk, Susanne Unverzagt, Eva Johanna Kantelhardt (2022). **Health system cost of breast cancer treatment in Addis Ababa, Ethiopia.** PLoS ONE 17(10): e0275171. https://doi.org/10.1371/journal. pone.0275171

Contribution as an author:

Since I was principal investigator, I was the key person in the research proposal writing, tool development, supervising the translation of the tool to local languages, conducting the pilot study, recruiting, and training data collectors, supervising the data collection, supervising the data cleaning process before data entry, creating the data entry template, data analysis, manuscript writing, and I was the corresponding author in the paper publication process.

Publication two: Tamiru Demeke, Damen Hailemariam, Pablo Santos, Edom Seife, Adamu Addissie, Eric Sven Kroeber, Rafael Mikolajczyk, Birgit Silbersack, Eva Johanna Kantelhardt, Susanne Unverzagt. **Willingness and ability to pay for breast cancer treatment among patients from Addis Ababa, Ethiopia: A cross-sectional study**. PLoS ONE 19(3): e0300631. https://doi.org/10.1371/journal. pone.0300631

Contribution as an author:

Since I was principal investigator, I was the key person in the research proposal writing, tool development, supervising the translation of the tool to local languages, conducting the pilot study, recruiting, and training data collectors, supervising the data collection, supervising the data cleaning process before data entry, creating the data entry template, data analysis, and manuscript writing.

PLOS ONE

RESEARCH ARTICLE

Health system cost of breast cancer treatment in Addis Ababa, Ethiopia

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Abstract

Background

Breast cancer is the leading cancer among women with an annual crude incidence of 27.4 per 100,000 in Ethiopia. The aims of this study were to (a) estimate the unit cost of breast cancer treatment for the standard Ethiopian patient, (b) identify the cost drivers, (c) project the total cost of breast cancer treatment for the next five years, and (d) estimate the economic burden of the disease in the main specialized tertiary hospital—Tikur Anbessa Specialized Hospital (TASH) Addis Ababa.

Methods

Primary data were collected from health and non-health professionals. Secondary data were collected from patient's charts and official reports from various national and international organisations including data from TASH. To establish work-time estimates, we asked professionals on their time usage.

Result

A total of US$ 33,261 was incurred to treat 52 Addis Ababa resident female breast cancer patients in TASH between July 2017 and June 2019. The unit cost of treatment for a hypothetical breast cancer patient to complete her treatment was US$ 536 for stage I and US$ 705 for stage II and III using the existing infrastructure. This cost increased to US$ 955 for stage I and US$ 1157 for stage II and III when infrastructure amortization was considered. The projected total costs of breast cancer treatment in TASH is between US$ 540,000 and US$ 1.48million. However, this will increase to US$ 870,000 and US$ 2.29 million when the existing fixed assets are changed.

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Competing interests: The authors have declared that no competing interests exist.

Conclusion

The economic burden of breast cancer treatment is high compared to the economic status of the country. Thus, it is recommended that TASH should revise its charges and breast cancer should be included in the Social and Community based health insurance scheme.

JEL classification: H51, H75, I18, P46

Introduction

Breast cancer is a disease that is manifested when cells in the breast grow and divide uncontrollably resulting in a mass of tissue which is usually known as a 'tumor'. The symptoms of breast cancer are abnormal lump or swelling in the breast, the most common symptom, the lumps beside the breast or under the arm, unexplained breast pain, abnormal-nipple discharge, changes in breast texture, or changes in the skin on or around the breast [1, 2]

Thus, breast cancer is characterized by the presence of malignant tumors in one of the organ's structures, which arise from the uncontrollable reproduction of cells that have gone through a complex process of disordered transformations and may progress through direct extension or metastatic dissemination [2].

Staging describes how much cancer is present in the patient's body. The size and location of the tumor, as well as the spread the cancer to other parts of the patient's body are the factors, among others, that influence staging a breast cancer. The American Joint Committee on Cancer's TNM classification system is used to stage invasive breast cancer (AJCC) [3].

Accordingly, the basic stages of breast cancer are stage 0, I, II, III and IV and each of them are elaborated as follow.

Breast cancer Stage 0 is defined as the cancer cells are not non-invasive. It is also known as ductal carcinoma in situ. This means there is no evidence of cancer cells or non-cancerous abnormal cells breaking out of the area of the breast where they began, or of getting through to or invading neighboring normal tissue.

Breast cancer stage I refers to an extremely early stage of invasive cancer. Tumor cells have spread to normal surrounding breast tissue but are still contained in a small area at this point.

Breast cancer stage II cancer is defined as cancer that has spread beyond a specific region of the breast. It shows the number of lymph nodes that may contain cancer cells.

Breast cancer stage III breast cancer means that the cancer has spread further into the breast or that the tumor is larger than in earlier stages.

The most advanced stage of breast cancer is stage IV. It has spread to nearby lymph nodes as well as distant areas of the body outside of the breast. This means it could affect the organs, such as your lungs, liver, or brain, as well as your bones [4–7].

The exact causes of breast cancer are largely unknown but demographic change, an unhealthy lifestyle due to economic transition, urbanization, hormonal factors, a family history of breast cancer, and a sedentary lifestyle, among others, played a paramount role in the rising incidence and prevalence of breast cancer in Africa in the last two decades [8–10]. For instance, according to cancer registry reports, breast cancer incidence rised by 3.7% in Uganda and 6.5% in South Africa per year. Moreover, most of the time, African breast cancer patients visit health facilities for treatment only after their breast cancer reached advanced stage. This is mainly due to a lack of awareness about the nature of breast cancer, insufficient screening services, large distances to health facilities, low health seeking behaviour, and poverty [11]. Consequently, treatment was more often palliative than curative [12] and breast cancer is the major cause of mortality and morbidity among women in Africa [8].

The breast cancer burden in Ethiopia was compared with neighboring and peer African countries. The Global Cancer Observatory recent report indicated in 2020 female breast cancer five years prevalence was 48.52 per 100,000 which was Somalia (31.61/100,000) and South Sudan (25.72/100,000) but lower than Eritrea (48.73/100,000), Uganda (55.46/100,000), Sudan (55.62/100,000), Kenya (57.28/100,000), Nigeria (59.31/100,000), Djibouti (74.71/100,000) and South Africa (138.90/100,000) [13].

Breast cancer is the most common and frequently diagnosed disease among women in Ethiopia. According to the GLOBOCAN report, 16,133 women were newly diagnosed with breast cancer in 2020 [14]. The Five-Year National Cancer Control Plan of Ethiopia (2015–2020) indicated a need of US$ 93 million for activities related to cancer prevention, screening, diagnostic, and treatment [15]. The importance of costing has risen over time, mainly because it can help policy makers to develop appropriate health financing policies and strategies for health facilities. A costing study serves as the basis for establishing user fees, evaluating whether health care providers are cost effective, and assessing how resources are used effectively and efficiently [16–18].

This study intended to (a) estimate the total cost of breast cancer treatment for standard breast cancer patients in different stages of the disease, who completed treatment, (b) identify the most important cost drivers, (c) provide evidence on the annual budget needed for full treatment for breast cancer patients at each stage for the next 5 years, and (d) show the economic burden of the disease in Addis Ababa City.

Methods

Study setting

This study was undertaken in the Radiotherapy Center, Tikur Anbessa Specialised Hospital (TASH) in 2018. 84 health professionals (5 oncologists, 41 clinical oncology residents, 1 general practitioner, 3 medical physicists, 2 radiotherapy technicians, 4 pharmacists, 6 radiographers residents), 22 nurses and 6 non-health professional (1 porter, 2 chart keepers, 1 cashier, and 2 secretaries) had been working in the Center, which had a computer tomography (CT) Simulator for diagnosis, a Cobalt 60 for cancer treatment and 18 beds for cancer patients.

Data collection

Primary data using questionnaires were collected from health professionals, who were working in the Radiotherapy Center as well as in other medical and non-medical departments of TASH from July to December 2019. The questionnaires were distributed to 22 respondents, who were selected from pathology, laboratory, pharmacy, surgery, anaesthesiology, oncology, and radiology departments. When the questionnaires were distributed to each respondents, they were asked to read the consent form and sign on it before they start to fill the questionnaire. Thus, all the respondents who filled the questionnaire signed on the consent form. Moreover, the time required to treat a single breast cancer patient was estimated by asking each professional and observing their actual time while they provide health care services.

Secondary data were collected from official reports from TASH, the Ethiopian Ministry of Health and the World Health Organisation. Other quantitative data such as employees salary, cost of pharmaceuticals, construction cost per m^2, Real Gross Domestic Product, foreign exchange rates, governmental total budget, and the government's budget for health and population growth were collected from official reports from TASH departments, the National Bank of Ethiopia, the Ministry of Finance, the International Monetary Fund, and the Central Statistical Agency. The tax revenues that the Ethiopian government will collect during the next five years were forcasted to obtain the total budget to be allocated for health care services.

Prior to extracting data from the patients charts, discussion was made with Oncology department head to anonymized all data to be collected from the charts. Following this, breast cancer treatment data were extracted from 55 selected patients' charts, who were treated between July 2016/17 and June 2018/19. The charts contained full information about the complete treatment given to the patients. For this study, a breast cancer patient was considered to have completed treatment if she took 8 cycles of chemotherapy.

Methods of cost estimation

Costs of breast cancer treatment were calculated at three levels: (a) First, the unit cost of each cost driver and service, (b) the total cost for a single breast cancer patient, and (c) lastly the total cost to treat all breast cancer patients annually (2021–2025), which will be expected to be presented at TASH.

All cost drivers of breast cancer treatment were first identified, and the unit cost of each cost driver was computed using the apportioning method as indicated in Table 1. The salary data were taken from the payroll, which the human resource department of TASH provided. The salaries of human resources were estimated by multiplying hourly salaries and the total time spent to treat each patient. The existing buildings were measured in meter. The unit costs of medical and non-medical furniture and equipment were calculated using cost data from the fixed asset registration book, as well as information from contacted heads of department.

Fixed assets are defined as all types of assets that can provide service for more than one year that includes office and medical furniture, Office and medical equipment, medical and non-medical machines, buildings, land, etc.

The total costs of these items for breast cancer treatment were then calculated by multiplying the unit costs by the number of items utilized and depreciation over time. Depreciation is the value that decrease every time when a fixed asset is used. The cost of each consumable medical item was made available by the Pharmacy of the Radiotherapy center and the main

Table 1. Sources of data and apportioning method for estimating the unit of cost of each cost driver.

Cost driver	Source of information	Units	Apportioning method
Salary of employees	Payroll copy from Human Resource Department	ETB converted to US$	Average monthly salary converted to hourly wage and multiplied by the time estimated for the specific activity
Building	Data collected from construction professionals	Area and ETB converted to US$	Annual depreciation divided by the total number of working hours and multiplied by the amount of time the patient received service
Medical and non-medical furniture and equipment	Data were collected from shops that sold the items	Number of items used	Annual depreciation divided by the total amount of working hours and multiplied by the amount of time the patient received service
Consumable materials and drugs	Pharmacy stores of TASH	Number of items consumed	Based on the dosage determined for the specific treatment
Radiotherapy	Medical physicist unit and patients register in radiotherapy room	Radiation dosis (Gray) given to patients	•The Cobalt 60 radiation source was depreciated for 5½ years and the investment divided by the total doses (Gy) provided to patients during the above-mentioned years •The unit cost of the Cobalt 60 machine was depreciated by 10 years, but since the machine served for more than 10 years, the depreciation value was zero
Overhead costs	The costs of different materials and activities that were used jointly by the Oncology department and other (e.g. utilities, security guard)	ETB converted to US$	10 % of the total of the above costs were taken

ETB: Ethiopian Birr; TASH: Tikur Anbessa Specialized Hospital; US$: United States of America Dollar.

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Table 2. Costed consumable materials.

Service type	Costed consumable materials	Costing method
Consultation	Patient card, pen, prescription papers, and gloves	Unit costs of each materials times number of materials used
Laboratory	Chemicals/reagents for diagnosis	Costs of each type of chemical/ reagents per mg times the quantity of chemical/ reagents used
Pathology	Chemicals, reagents and other related materials for diagnosis	Costs of each type of chemical/ reagents per mg times the quantity of chemical/ reagents used plus the unit costs of each materials times number of materials used
Ultrasound	Ultrasound paper and gel and other related materials for diagnosis	Costs of gel per mg times the quantity of gel used plus the unit costs of each materials times number of materials used
X-ray	Gloves and CD for diagnosis	Unit costs of gloves and CD times number of gloves and CD used
CT-Scan	Gloves, contrast, plastic sheet and other related materials used in the CT scan room for diagnosis	Unit costs of gloves, plastic sheet and other related materials times number of gloves, plastic and other related materials used plus costs of contrast per mg times the quantity of contrast used.
Anesthesia	Chemicals and other related materials for surgery.	Costs of each type of chemical/ reagents per mg times the quantity of chemical/ reagents used plus the unit costs of other related materials times number of other related materials used.
Surgery	Gauze, blades, and other related materials.	Unit costs of gauze, blade and other related materials times number of gauze, blade and other related materials used.
Radiotherapy	The Cobalt 60 radiotherapy source and related materials	Costs per Gray times the quantity of Gray plus the unit costs of other related materials times number of other related materials used.
Chemotherapy	Chemotherapy drugs (e.g. FEC, CMF, and Doxorubicin ACT) and other related materials.	Unit costs of each drug times the quantity of drug plus the unit costs of other related materials times number of other related materials used.

ACT: (Adriamycin)/ Cyclophosphamide (Procytox)/ Paclitaxel (Taxol) CMF: Cyclophosphamide/Methotrexate/ Fluorouracil, FEC -Fluorouracil/Epirubicin/Cyclophosphamide

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pharmacy department of TASH. The total costs of each service was obtained by multiplying the unit costs of each material by the quantity of the materials used. The grand total of all services was found by summing up the total costs of each service. To include the costs of items that are commonly utilized by all departments of TASH, 10% of the total costs of other items were taken as overhead cost.

The types of services that will be provided to breast cancer patients were identified as listed in Table 2. The costs of drugs that were prescribed and subsequently bought by patients, including endocrine treatment (Tamoxifen) were not included, because TASH does not supply these drugs.

The units and total costs of breast cancer treatment were estimated in two scenarios. The first scenario did not include depreciation of fixed assets such as medical and non-medical equipment, machines and furniture, because these items were too old and did not have book value even if they are still giving services. The second scenario includes depreciation by using the depreciation values of the fixed assets based on their current prices, if TASH replaced the existing old fixed assets by new items and renovated the existing old building. Annual depreciation for fixed assets were computed using straight-line depreciation method over different years according to the council of ministers regulation on the federal income tax [19]. Accordingly, computers, software, all medical and non-medical machines and office furniture were

depreciated by 20%, while the Cobalt 60 machine was depreciated by 15%, and building was depreciated by 5% annually. However, depreciation of the source of Cobalt 60 was calculated based on the amount of radiation Gray used and leaked every year.

The medical and non-medical consumable materials were procured between August and October 2019. To estimate the costs of the aforementioned materials in July 2017 and 2019, the costs were discounted by 15 percent due to inflation during these years and converted to US$ using the average exchange rates of the these years. Thus, the treatment costs computed for these patients reflected the costs that TASH incurred during the above-mentioned years.

Following the identification of the types of diagnosis and treatment provided, the costs incurred for breast cancer treatment for a single patient using the prevailing breast cancer treatment practice were estimated.

The new cases of breast cancer were projected based on the growth of the female population per age and the annual growth of incidence rate of breast cancer as per the record of AAPBCR.

The total costs of breast cancer treatment were calculated by multiplying the unit costs of each service by the number of breast cancer patients, who will be treated during the next five years.

These costs were estimated in two scenarios. The first scenario was using the existing fixed assets including building as they are and second scenario was after renovating/replacing the existing building and fixed assets by new ones. These costs were also estimated in three scenarios by assuming the unit costs of inputs will be increased by 10%, 15% and 20%.

It is assumed that TASH will treat all the projected new breast cancer patients using the existing practice and infrastructures. Following these steps, the total costs were estimated in Ethiopian Birr and then changed in US$ using the Wallet Investor website [20].

The economic burden of the projected cost of breast cancer treatment was estimated in terms of the share of the total health budget allocated at a national level, as it is difficult to estimate the health budget in Addis Ababa due to a lack of reliable data. Ethiopia's RGDP for the next five years was forecasted using Autoregressive and Moving Average (ARIMA) and Seasonal Auto Regressive Integrated and Moving Average (SARIMA) models [21, 22].

Ethical consideration

The author obtained ethical approval from the Institutional Review Board of the College of Health Sciences, Addis Ababa University, prior to conducting the study. The study participants provided their consent in writing by signing on the informed consent form attached with the questionnaire.

Results

Costs of breast cancer treatment services for a single patient

A total of 55 breast cancer patients were assessed. Of these, three were stage I, 12 stage II, 29 stage III, eight stage IV and three of an unknown stage. These three patients were categorized as unknown stage because Oncologist did not mention the breast cancer stages in patients' charts. Because of this, these patients were excluded from further considerations. Out of 52 patients, 42 received modified radical mastectomy. When these 42 patients were disaggregated by their stage of breast cancer, 2, 8, 29 and 3 patients were at stage I, II, III and IV respectively. Similarly, among 39 patients to whom radiotherapy was provided and of these 7, 29 and 3 patients were at stage II, III and IV respectively. Chemotherapy was provided to all patients. The chemotherapy and radiotherapy treatments were provided to breast cancer patients in accordance to National Comprehensive Cancer Network Harmonized Guidelines for Sub-

Table 3. Unit cost for treatment by breast cancer stage (April 21, 2020).

Type of service	Cost of treatment per stage in US$ (%)					
	Scenario I excluding fixed assets			Scenario II including fixed assets		
	Stage I	Stage II	Stage III	stage I	Stage II	Stage III
Consultation/ Examination	31 (60%)	31 (4%)	31 (4%)	69 (7%)	69 (6%)	69 (6%)
Laboratory	36 (7%)	36 (5%)	36 (5%)	91 (10%)	91 (8%)	91 (8%)
Pathology	20 (4%)	20 (3%)	20 (3%)	72 (8%)	72 (6%)	72 (6%)
Ultrasound	3 (1%)	3 (0.5%)	3 (0.5%)	13 (1%)	13 (1%)	13 (1%)
X-Ray	2 (0.4%)	2 (0.3%)	2 (0.3%)	14 (2%)	14 (1%)	14 (1%)
CT-Scan		51 (7%)	51 (7%)		55 (5%)	55 (5%)
Surgery	148 (28%)	148 (21%)	148 (21%)	209 (22%)	209 (18%)	209 (18%)
Radiotherapy		118 (17%)	118 (17%)		147 (13%)	147 (13%)
Chemotherapy	297 (55%)	297 (42%)	297 (42%)	488 (51%)	488 (42%)	488 (42%)
Total	**536 (100%)**	**705 (100%)**	**705 (100%)**	**955 (100%)**	**1,157 (100%)**	**1,157 (100%)**

Source: Authors' calculations based on the data collected from respondents

Note: Due to rounding, the sums may not be equal to the total

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Saharan Africa (NCCN) guidelines by prescriping 8 cycles chemotherapy and on average 39 Gray in 13 fractions radiotherapy.

Accordingly, this study found that TASH incurred US$ 33,261 for provision of full treatment for 52 breast cancer patients. When this amount was disaggregated by breast cancer stages, TASH expended US$ 1855, 8221,19558, and 3626 to treat breast cancer patients with breast cancer stage I, II, III and IV respectively. The total costs of breast cancer treatment were again itemized by the type of diagnosis and treatment provided. Accordingly, The cost of chemotherapy, radiotherapy, laboratory and other services was $11211, 7253, 4333 and 10464 respectively.

The cost per patient for each stage was calculated and stage I, II, III and IV were found to cost US$ 618, 735,772 and 584 respectively.

Unit cost of breast cancer treatment by stages and scenarios

Unit cost for treatment by cancer stage is presented by stages and in two scenarios (Table 3). According to scenario I (excluding the values of fixed assets), the treatment costs for breast cancer stage I was US$ 536 whereas for stage II and III the costs of treatment were US$ 705 each. These costs increased to US$ 955 to treat breast cancer stage I and US$ 1157 to treat breast cancer stage II and III each, when the values of fixed assets were included (Table 3). Chemotherapy, surgery, and radiotherapy services took the largest portions of the total cost among the services offered to breast cancer patients, as shown in Table 3.

When the replacement and renovation costs of fixed assets are included (scenario II), the costs of some services were increased while the costs of other services decreased (Table 3).

Cost of treating breast cancer per type of input

In scenario I, consumable materials and human resources took the lion shares of the total cost of breast cancer treatment for all stages using the existing fixed assets. However, if the existing assets are replaced by the new one and the buildings are renovated, the share of each input will vary. With scenario II, the share of consumable materials and human resources was decreased to 38% and 13% for stage I and 39% and 13% for II and III respectively. The costs of medical

Table 4. Cost of breast cancer treatment by type of input (April 21, 2020).

Type of inputs to be used	Treatment cost per type of input and stage of breast cancer in US$ (%)					
	Scenario I excluding fixed assets			Scenario II including fixed assets		
	I	II	III	I	II	III
Consumable materials	360 (67%)	456 (65%)	456 (65%)	360 (38%)	456 (39%)	456 (39%)
Human resource	124 (23%)	150 (21%)	150 (21%)	124 (13%)	150 (13%)	150 (13%)
Medical equipment, machines and furniture	2 (0.5%)	34 (5%)	34 (5%)	101 (11%)	133 (12%)	133 (12%)
Non-medical equipment, machines and furniture	0.3 (0.1%)	0.4 (0.1%)	0.4 (0.1%)	23 (2%)	24 (2%)	24 (2%)
Building	0(0%)	0.2 (0.0%)	0.2 (0.0%)	259 (27%)	288 (25%)	288 (25%)
Others	49 (9%)	64 (9.%)	64 (9%)	87 (9%)	105 (9%)	105 (9%)
Total	**536 (100%)**	**705** (100%)	**705** (100%)	**955** (100%)	**1,157 (100%)**	**1,157 (100%)**

Source: Authors' calculations based on the data collected from respondents.

Note: Due to rounding, the sum may not equal to the total

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equipment, machines and furniture increased to 11% for stage I and 12% to treat stage II and III. The costs of non-medical equipment, machines and furniture increased from 0.1% to 2% to treat stage I, II and III of breast cancer. On the other hand, the construction cost has increased from 0% to 27% for Stage I and 25% for Stage II and III (Table 4).

Comparison of cost of treatment between current practice and NCCN guidelines

Breast cancer treatment costs for one patient at each stage of current Ethiopian practice in TASH and NCCN are similar for nearly all types of services (Table 5). Differences were observed in CT scan diagnosis, which is not prescribed in the current treatment practice while NCCN guideline prescribed it for breast cancer stage I patients. The amount of Gy prescribed in the current radiotherapy treatment practice is a little bit higher than the amount Gy prescribed in NCCN guideline. The total cost of breast cancer treatment with the current

Table 5. Comparison of breast cancer treatment costs between current practice and NCCN guidance (as of April 21, 2020).

Type of service	Cost of BC treatment by stage of breast cancer (US$)							
	As per the current practice				As per NCCN Guidelines			
	Qty	I	II	III	Qty	I	II	III
Consultation/examination	8 visits	31	31	31	8 visits	31	31	31
Laboratory	8 times	36	36	36	8 times	36	36	36
Pathology	1 time	20	20	20	1 time	20	20	20
Ultrasound	1 time	3	3	3	1 time	3	3	3
X-Ray	1 time	2	2	2	1 time	2	2	2
CT-Scan	1 time		51	51	1 time	51	51	51
Surgery	1 time	148	148	148	1 time	148	148	148
Radiotherapy	53.68 Gy		118	118	50 Gy		160	160
Chemotherapy	8 Cycles	297	297	297	8 Cycles	297	297	297
Total		**536**	**705**	**705**		**587**	**747**	**747**

NCCN: National Comprehensive Cancer Network Harmonized Guidelines for Sub-Saharan Africa, Qty: Quantity

Source: Authors' computation based on the data collected from respondents and NCCN guidelines

Note: Due to rounding, the sums may not be equal to the total

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Table 6. Projection of the total costs of breast cancer treatment excluding and including the values of fixed assets from the year 2021 to 2025.

Year	Number of patients	Scenario I excluding fixed assets in thousands			Scenario I including fixed assets in thousands		
		10%	15%	20%	10%	15%	20%
2021	670	540	560	590	870	910	950
2022	700	620	680	740	1,000	1,100	1,190
2023	723	700	800	910	1,140	1,300	1,480
2024	748	800	960	1,113	1,300	1,550	1,840
2025	776	910	1,140	1,410	1,480	1,850	2.290

Source: Authors' computation based on the data collected from AAPCR, CSA and data collected from TASH documents and reports

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treatment practice is US$ 536 to treat a patient in stage I and US$ 705 for stage II and III compared to the total cost of breast cancer treatment per NCCN guideline as US$ 587 for stage I and US$ 747 for breast cancer stage II and III.

Projected costs of breast cancer treatment

The number of new breast cancer patients in Addis Ababa, who might seek treatment in TASH will follow the growth of the female population per age [23] and increase from 670 in 2021 to 776 in 2025 (Table 6).

If the unit costs of materials will increase by 10 percent every year, the total cost of breast cancer treatment for TASH will increase from US$ 540,000 in 2021 to US$ 910,000 in 2025 (Table 6). If the unit costs of materials will increase by 15%, TASH will incur from US$ 560,000 in 2021 to US$ 1.14 million in 2025. However, if the unit costs of medical and non-medical materials increased by 20%, TASH will be forced to incur from US$ 590,000 in 2021 to US$ 1.41 million in 2025.

The estimated costs excluding amortization in scenario I are too low. Thus, the depreciation values of fixed assets were included assuming that the old but functional fixed assets will be either replaced by new one or renovated (scenario II). If the prices of medical and non-medical both resources will increase by 10%, the cost of breast cancer treatment will be increased to US $ 870,000 in 2021 and US$ 1.48 million in 2025 to treat 670 and 776 breast cancer patients respectively. This cost will increase to US$ 910, 000 and US$ 1.85 million in 2021 and 2025 respectively to treat the same number of breast cancer patients. When the prices of both medical and non-medical resources will increase by 20%, the cost of breast cancer treatment will increase to US$ 950, 000 and US$ 2.29 million (Table 6).

Economic burden of breast cancer

The economic burden of the health care service is determined by the share of the total health budget as well as the gross domestic product. Accordingly, if TASH continues to provide treatment, using the existing infrastructure assuming that the costs of inputs will increaseby 10%, 15% and 20%, the share of the costs of breast cancer treatment to the total health budget will be 0.042%, 0.043% and 0.045% in 2021 respectively. These shares will be increased to 0.065%, 0.081% and 0.1% in 2025. If TASH replaces the old medical and non-medical machines, equipment and furniture by new one and the existing building is renovated and if the costs of inputs increased by 10, 15 and 20%, the share of the breast cancer to the total health budget will be 0.067, 0.070 and 0.073% in 2021 respectively and these shares will be increased to 0.105, 0.131 and 0.162% in 2025.

Discussion

This study found considerable differences of costs for optimal treatment regimen of breast cancer patients. Chemotherapy was the most expensive, followed by radiotherapy and consultation costs. This study found that according to the current treatment practices at TASH, the total costs of breast cancer treatment significantly increased with higher stages of disease. Patients with stage two and three disease needed more expensive treatment compared to stage one. Out of the total cost incurred to optimally treat 55 breast cancer patients, 6% were spent for treatment of patients with stage I, 26% for stage II and 61% of the total cost for stage III breast cancer patients. Costs for all new breast cancer patients, who will present at TASH for treatment during the next five years were projected [24].

Guzha et al. also found somewhat similar findings that of the total cost of breast cancer treatment 6%, 47% and 35% of costs were incurred for treating stage I, II and III cancer respectively, though these costs were paid by the patients [25]. However, Nguyen et al indicated in their study that the initial treatment cost of breast cancer treatment was only US$ 128.7 for stage I but US$ 684.1 for stage III; for stage IV the treatment cost decreased to US$ 537.9. The five year total treatment cost increased from US$ 568.6 for stage I to US$ 901.8 for stage II but for stage III and IV the treatment cost decreased to US$ 816.1 and US$ 603.4 respectively. The reason for this decline was that the follow-up treatment for breast cancer in the years after the initial treatment was relatively simple [26]. Certainly the costs per patient increased with higher stages seeing the majority of patients treated for advanced stage further increased the costs. Furthermore, this study found that TASH incurred US$ 11,704 for chemotherapy which was US$ 180.66 per patient. Those studies, which were conducted at TASH, Addis Ababa, Ethiopia and Groote Schuur Hospital, Cape Town, South Africa, indicated that patients incurred far higher costs on average US$ 1,188 and US$ 1,489 for chemotherapy respectively [25]. A study conducted in Moroco on Unit price for different drugs, cost of protocols by cycle and cost of individual whole treatment, the unit cost of chemotherapy drugs for example Cyclophosphamide (1000 mg) was US$ 7.28. The total cost of chemotherapy treatment was also US$ 84.50 for AC, US$ 1105 for Docetaxel and US$ 1560 for Trastuzumab [27]. In Vietnam the average cost of chemotherapy treatment was US$ 476.48 [26]. This shows that chemotherapy costs were rather low in Addis Ababa compared to other settings were more modern substances are used.

Consumable materials took a high share out of the total costs of breast cancer treatment in all scenarios. If maintenance costs were included such as renovation of existing buildings, the share of the cost for building-renovation would be higher than the share of cost of human resources. In terms of costs of utilized for consummable inputs, the advanced stages were more costly than earlier stages of breast cancer. The costs of breast cancer treatment according to the NCCN guideline for SSA was slightly higher than the costs of breast cancer treatment according to current practice due to differences in imaging utilization and low-cost radiotherapy.

Total costs certainly depend on numbers of patients in need for therapy. The projection of the number of new breast cancer cases based on AAPBCR and CSA data indicated an increase. This projection might even be an underestimate, because with expected higher awareness, the number of Addis Ababa residents, who demand breast cancer treatment may increase. As the number of breast cancer patients will increase from year to year, the budget to be allocated would need to rise to US$ 1.5 million in 2025. This is due to the increase of investment costs for newly procured medical and non-medical equipment and furniture, as well as the cost of renovation of the existing building (increase on average by 144%). Because of this, the estimated and projected total cost of breast cancer treatment will be 1.02% and 1.251% of the total

health budget in 2021 and 2025 respectively. This will compel TASH to mobilise resources from both domestic and foreign sources. High costs for breast cancer treatment are also reported from other countries. Saber Boutayeb et al. also revealed that the cost of chemotherapy treatment for a breast cancer patient varies between US$ 507 up to US$ 30,088. In Vietnam also, the initial treatment and 5-Year total cost for treatment course was US$ 632.86 and US$ 975.01 respectvely [26]. The government of Moroco was suggested to allocate annual between US$ 13.3 million and US$ 28.6 million for breast cancer treatment [27]. These studies show that understanding the total cost of breast cancer treatment is critical, as it will inform the decision-makers on financing breast cancer treatment.

In summary, this study found that the budget required to provide breast cancer treatment for new patients depends on the number of new patients, the proportion of advanced stage as well as the detailed decision on costly targeted therapy such as trastuzumab. It should be noted that, promoting of earlier treatment of breast cancer should be given high priority to considerably reduce the economic burden of breast cancer treatment as well as increasing survival rates [28, 29].

Thus, the Ministry of Finance and Ministry of Health of Ethiopia and TASH are advised to use the data and findings of this study as a baseline, while planning and budgeting for breast cancer prevention and treatment.

Moreover, from a public health perspective, the reported data in this study can be used as a resource to develop ideas on budgeting for the different components of breast cancer therapy.

Limitation of the study

The study has the following limitations: First, the study focused on the treatment given at TASH only. TASH is the most comprehensive cancer center in the country and sets high standard. We purposely choose a guideline concordant approach to assure the maximum benefit to the patients. Second, the study did not include the costs incurred to treat breast cancer stage IV, costs of treatment for adverse effects of medication given to breast cancer patients, and costs for breast cancer inpatient treatment. This would add additional costs but can have very high variability due to personal preferences and individualized approaches. Third, additional factors such as inflation, pandemic or difficulties of procurement may also alter prices of items.

Conclusion

This study shows the magnitude of current costs for breast cancer service in Addis Ababa, Ethiopia. In detail, main drivers are advanced stage, investment costs such as radiotherapy machine as well as the increasing total number of patients in need of care. Hence, to alleviate the economic burden of breast cancer treatment, promoting of early diagnosis is vital. Nevertheless, it should be noted that as women's awareness about the benefits of breast cancer treatment increase, the demand for innovative breast cancer treatment would rise as well. Negotiations with pharmaceutical companies could possibly provide access to modern therapy for low-resource countries. In general, innovative financing mechanisms have to be found to meet the demand for cancer care. Hence, we recommend that international partnership should be sought to assure costly investments, policies should be carefully revised and social and community based health insurances should include breast cancer in their schemes.

Supporting information

S1 File. Estimted cost of breast cancer treatment at TASH.
(XLSX)

S2 File. Unit costs of breast cancer treatment.
(XLSX)

S3 File. Comparison of the cost of BC treatment.
(XLSX)

S4 File. Projected BC treatment cost.
(XLSX)

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RESEARCH ARTICLE

Willingness and ability to pay for breast cancer treatment among patients from Addis Ababa, Ethiopia: A cross-sectional study

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Abstract

Introduction

Breast cancer (BC) is the most common malignant neoplasm among women in Addis Ababa, Ethiopia. The willingness and ability to pay (WATP) for treatment is a contributing factor in the utilization of health care services. The World Health Organization Breast Cancer Initiative calls for 80% of patients to complete multimodality treatment and indicates payment as central factor to improve BC outcome. The objectives of this study are to identify how much female BC patients paid in Addis Ababa for BC treatment, their WATP for BC treatment, and the factors that affect WATP.

Methods

The researchers collected data from 204 randomly selected BC patients who were treated in one of four different health facilities (one public and three private) between September 2018 and May 2019. A structured questionnaire was used to assess their WATP for BC treatment and multivariable regression to investigate factors associated with patients' WATP.

Results

Of interviewed patients, 146 (72%) were at reproductive age. Patients' median expenditure for all BC treatment services was 336 US dollars (USD) in a public cancer center and 926 USD in privately owned health facilities. These amounts are in contrast with a reported WATP of 50 USD and 149 USD. WATP increased with increasing expenditure (OR 1.43; 95% CI 1.09 to 1.89 per 100 US), educational level (OR 1.37; 95% CI 1.02 to 1.85) and

replicate all study findings reported in the article can be found under doi: 10.6084/m9.figshare.25370860.v2 The python script showing all steps to reproduce data cleaning, model building, regression coefficients with 95%CI and and p-values can be found under doi: 10.6084/m9.figshare.25370950.v1.

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service quality (OR 1.34; 95% CI 1.04 to 1.72). In contrast, a monthly income increase by 100 USD corresponds to a 17% decrease of WATP (OR 0.83; 95% CI 0.70 to 0.99).

Conclusions

We demonstrated that BC treatment was very expensive for patients, and the cost was much higher than their WATP. Thus, we suggest that BC should be included in both social and community-based health insurance plans and treatment fees should consider patients' WATP.

Introduction

Breast cancer (BC) is a growing public health challenge in Ethiopia [1,2]. According to data from the Addis Ababa Population Based Cancer Registry, the cumulative BC incidence in the capital city alone reached 4,500 cases as of 2019 [3]. The GLOBOCAN 2020 report indicated that in Ethiopia there were 16133 new BC cases and 9061 deaths due to BC. These figures put the country in the third rank among African countries [4].

Many breast cancer patients seek treatment at the Tikur Anbessa Specialized Hospital-Radiation Centre (hereafter called Public Cancer Centre [PCC]) to get treatment as, until 2022, it was the first and only government owned hospital that provided cancer treatment including radiotherapy. In addition, there are three privately owned health facilities in Addis Ababa that provide oncology service but are limited to chemotherapy only [5]. Among patients who presented in PCC for treatment, almost 71% were diagnosed at advanced stages due to lengthy intervals between the time of recognition of symptoms and getting treatment [6]. Apart from various medical and non-medical factors, many BC patients presented in both PCC and private health facilities (PHFs) at advanced stages due to low income and the high costs of BC treatment. Among these patients, some discontinued their treatment, frequently due to shortage of money [7–9].

Ethiopia's national health accounts reports indicated that out-of-pocket (OOP) expenditure accounts for about 30% of the total health expenditure [10]. This is also applicable to BC patients. The heavy reliance on OOP expenditure triggered policy makers to pay attention to the cost of health care services because a large OOP expenditure can make the health expenditure catastrophic [11]. An OOP expenditure is said to be catastrophic if it is above the estimated threshold share of household expenditure, which can result in patients being forced to sacrifice other basic needs, sell assets, incur debt, or be impoverished [12,13] or if the OOP expenditure is equal to or greater than 40% of non-food expenditure or capacity to pay (CTP). CTP is the difference between subsistence expenditure and monthly household expenditure (i.e., consumption [14]. This in turn will compel patients and their families to reduce consumption of basic necessities and this further will push them into poverty. Thus, the Federal Democratic Republic of Ethiopia (FDRE) Ministry of Health (MOH) prepared and implemented a five-year national cancer control program to reduce the financial burden [15].

Affordability of BC treatment is an important factor for optimal treatment compliance. The WHO Global Breast Cancer Initiative has recommended that 80% of patients should complete multimodal treatment with an affordable charge as an essential component for success [16]. To determine the affordability of treatment, it is paramount to know what patients are willing and able to pay (WATP) for treatment. Willingness to pay (WTP) refers to a person's willingness to pay for desired goods or services, while ability to pay (ATP) refers to their financial

capacity to do so. [17]. Therefore, it is recommended to combine these two concepts and use WATP to estimate the real demand for goods and services including health care services [18–22]. Accordingly, many studies assessed the demand for BC treatment using either the contingent valuation (CV, see Methods) technique for stated preferences or the conjoint analysis (CA) technique for revealed preference. The CV technique is generally recommended for health economics research [19,23–28]. The method has been validated and employed in several similar studies [20,29,30].

It is a survey approach designed to fill the gap in the market for public goods by asking how much money people are willing to pay (WTP) for specified goods or services including health care services [31].

Analyzing WATP is crucial for understanding the demand for health care services and provides evidence to both policy makers and health professionals regarding the determination of health care service fees [32], to guiding financial strategies to ensure access to recommended BC treatments for all patients, and providing treatment based on patients' economic [33–35].

The aims of this study were to (i) identify how much female patients were paying for their treatment both in public and private health facilities, (ii) investigate the WATP of BC patients living in Addis Ababa, and (iii) identify the factors that influenced their WATP.

Materials and methods

Study population

We conducted a quantitative cross-sectional study for which data was collected from BC patients who presented in one of four selected health facilities (one public and three privately owned) in Addis Ababa, Ethiopia. Data collection was done between September 2018 and May 2019. Data analysis was performed between April 2020 and January 2021. For this study, For this study, we included all BC patients permanently residing in Addis Ababa and receiving treatment at PCC and the three privately owned health facilities at the time of data collection. The sample design was simple random sampling that is BC patients who came to the aforementioned health facilities were randomly selected among those BC patients who came to the health facilities at the time of data collection.

Sample size calculation was done based on accuracy (two-sided width of the 95% confidence interval CI) of the estimate and an assumed standard deviation of direct medical costs of 355 USD per BC treatment, requiring a distance from the mean to both directions of 50 (width of the CI of 100) [36], resulting in a sample size of n = 194. In addition, 15% was added for non-response rate and the sample size became 223 patients. This sample size was distributed among the four health facilities in proportion to the number of BC patients they treated before data collection time using simple proportional allocation method. Accordingly, 133 patients from PCC and 90 patients from the three private health facilities were contacted.

Data collection

The data collection tool was a structured questionnaire consisting of the following sections (WHO): socio-economic, (1) history of BC and current health status (2), expenditures related to BC treatment, and (AAPCR) patients' WATP for BC treatment. To measure WATP, patients were asked how much they would be willing and able to pay for each health care service they receive based on their present experience, without considering the frequency of the service or the number of chemotherapy cycles. The questionnaire was prepared based on the CV technique that consists of open-ended and close-ended questions to ask patients the maximum amount they were WATP for their treatment.

Statistics

The data were processed with SPSS version 26, STATA version 15 and the Statsmodels library version 0.14.0 in Python [37]. Results of descriptive statistics were presented as absolute and relative frequencies, with the corresponding medians. We assessed the effects of sociodemographic and medical factors on patients' WATP while adjusting for confounders by using a multivariate regression model. Since WATP values did not follow a normal distribution, we avoided heteroscedasticity by fitting data as a generalized linear model (Gamma family with log link [38]). The exponentiated coefficients resulting from the multivariate regression were interpreted as Odds Ratios (ORs) [39,40]. The number of samples considered for the regression was the sample subset (n = 121) for which valid values were available for all assessed variables. Due to the lack of collinearity among the explanatory variables (Pearson's $\rho < 0.5$ for all variable pairs), imputations were not performed. The number of missing data points that led to the final sample subset of 121 patients assessed in the regression are given for each variable in Table 1.

Ethics approval

The Institutional Review Board (IRB) of the College of Health Sciences at Addis Ababa University in Ethiopia provided ethical approval prior to the collection of study data under Protocol Number 051/18/SPH. Informed consent was obtained orally from each patient at the beginning of the interview and documented on the questionnaire by the data collectors.

Results

Descriptive statistics

Of a total of 223 patients who were asked for interview, 204 (91%) agreed to participate in the study. Of the 204 interviewed patients, 151 (74%) were treated at PCC and 53 (26%) at the three PHFs. Patients were between 23 and 75 years old and 72% of patients were within reproductive age. Half of the patients were unemployed or housewives, 11% of patients were unable to read and write, and 69% were married. The median family size excluding the interviewed patient was four (range 0–12). 72% of patients were treated for up to two years. The most common symptoms leading to a diagnosis with BC were breast swelling (61%) followed by breast pain (28%) (Table 1).

Of the interviewed patients, 72% were willing to disclose their average monthly families' income. Of these, 31% had a monthly income below 75 USD. There was a broad range of monthly income between 5 and 1,011 USD (Table 1). Participants in the study were grouped according to their monthly income based on the World Bank's Poverty Assessment of Ethiopia and Ethiopia's low income tax rate. Accordingly, an income of less than 1.25 USD per day was considered the poverty line. [41]. Monthly income greater than 38 USD but less than or equal to 75 USD is considered lower-middle income, monthly income greater than 75 USD but less than or equal to 150 USD is considered middle income, and monthly income greater than 150 USD is considered upper income.

Patients' income sources were, their own (26%), their husband's salary (23%), a combination of their own income and their husband's salary (21%), pension (16%) or support from their children or other relatives (14%). Regarding average monthly household expenses, excluding expenditure for BC treatment, 56% spent more than 75 USD, with a median expenditure of 98 USD.

Expenditure and satisfaction with treatment

Most patients (82%) were satisfied with the treatment they received, while 57% of patients said the quality of the services was good or very good. However, 55% of patients deemed the treatments expensive.

Table 1. Demographic characteristics of patients (n = 204).

Characteristic	*n* (%) *
Age (years)	
23–49	146 (71)
50–75	58 (28)
Employment status	
Unemployed or housewives	101 (50)
Employed	73 (36)
Self-employed	26 (13)
Other	4 (2)
Educational level	
Without elementary level	54 (26)
Elementary or secondary school level	70 (34)
Higher education	78 (38)
Unknown	2 (1)
Marital status	
Single	23 (11)
Married	138 (68)
Ex-married (widowed, separated, or divorced)	43 (21)
Family size	
≤ 3	82 (40)
4 to 7	100 (49)
≥ 8	19 (9)
Unknown	3 (1)
Number of years with BC	
< 1	30 (15)
1	67 (33)
2	49 (24)
3	46 (23)
No response	12 (6)
Reasons for diagnosis	
A physician advised me to consult Oncologist about my BC when I went for other treatment	15 (7)
Breast swelling	118 (58)
Breast pain	59 (29)
No response	12 (6)
Average monthly income (USD)	
≤ 38	34 (17)
> 38 to ≤ 75	29 (14)
> 75 to ≤ 150	41 (20)
≥ 150	42 (21)
No response	58 (28)

BC = Breast cancer; USD = United States Dollar

* Sums may not add up to 100% due to rounding.

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Patients treated at PCC paid a median of 336 USD (interquartile range [IQR] 97 to 711), whereas patients treated in PHFs paid a median of 926 USD (IQR 206 to 1,581) for all services. Among the services provided at PCC, patients paid the highest median amount of 152 USD (IQR 76 to 253) for chemotherapy, followed by 126 USD (IQR 48 to 253) for surgery, and 106 USD (IQR 29 to 253) for medication. Patients treated at PHFs paid the highest median amount

Table 2. Comparison between PCC and PHFs concerning the amounts actually paid for each component of the BC treatment.

Service	Median (1)		IQR (USD)	
	PCC	PHF	PCC	PHF
Consultation	0.1 (112)	10.1 (52)	0.1–0.1	8.8–10.1
Laboratory	12.6 (90)	35.4 (42)	5.1–38.9	21.5–97.9
Medication	106.1 (103)	202.2 (37)	29.1–252.7	126.4–454.9
Imaging	13.9 (96)	15.2 (12)	5.1–39.2	7.0–25.3
Radiotherapy	25.3 (21)	N/A	7.6–176.9	N/A
Surgery	126.4 (76)	758.1 (25)	48.0–252.7	758.1–909.7
Pathology	7.6(87)	11.4 (35)	4.3–12.6	11.4–45.
Chemotherapy	151.6 (92)	88.4 (51)	75.8–252.7	29.9–202.2
Inpatient Service	75.8(76)	278.0 (10)	25.3–167.41	31.6–1,200.3
All Services	336.3 (145)	926.1 (5)	97.4–710.6	205.9–1,580.6

IQR: Interquartile range; USD: United States dollars; PCC: Tikur Anbessa Specialized Hospital-Radiation Centre; PHF: Private health care facilities; N/A: Not applicable.

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of 758 USD (IQR 758 to 910) for surgery; 278 USD (IQR 32–1,200) for inpatient service including all medical treatment, a bed, and meals; and 202 USD (IQR 126 to 455) for medication (Table 2).

About 36% of patients obtained financial support from relatives/friends and 20% used combinations of financial support, savings, and loans for their treatment. However, 79% of patients reported having difficulty obtaining money.

Willingness and ability to pay

151 patients treated at PCC had WATP median of 50 USD (IQR 19 to 134) and 53 patients treated at PHFs had WATP median 149 USD (IQR 66 to 383) for all health care services. Patients treated at PCC had WATP median 13 USD (IQR 2.5 to 37.27) for surgery, 13 USD (IQR 0.0 to 25.27) for chemotherapy and 13 USD (IQR 1.3 to 25.27) for inpatient service. The 13 USD was equivalent to 500 Birr and was higher than the median amounts of other health care services that were provided in PCC. Patients treated at PHFs were willing and able to pay a higher median amount of 253 USD (IQR 253 to 379) for surgery and 35 USD (IQR 23 to 76) for drugs (Table 3).

The costs incurred for treatment were analyzed by years since diagnosis. We found that the patients who were treated for up to two years paid the median amount of 505 USD, while patients who were treated for more than two years paid the median amount of 454 USD for the whole treatment period. The patients differed in their willingness and ability to pay depending on the duration of treatment (medians of 71 USD and 27 USD, respectively).

Factors affecting WATP for BC treatment

The results of the multivariable regression are listed in Table 4 WATP increased with the total expenditure of patients, educational level and service quality. An increase of 100 USD in total expenditure corresponded to an increase by 43% in WATP (OR 1.43, 95% CI 1.09 to 1.89). Likewise, each increased educational or service quality level corresponded to an increase by 37% and 34% in WATP respectively (OR 1.37; 95% CI 1.02 to 1.85 and OR 1.34; 95% CI 1.04 to 1.72). An income increase of 100 USD corresponded to a 17% decrease of WATP (OR 0.83; 95% CI 0.70 to 0.99).

Table 3. Comparison between PCC and PHFs concerning WATP for each component of the BC treatment (n = 204).

Service	Median (1)		IQR (USD)	
	PCC	PHF	PCC	PHF
Consultation	0.1 (151)	5.1 (51)	0.1–0.38	3.8–5.05
Laboratory	1.3 (133)	12.6 (38)	0.5–2.53	8.2–25.27
Drugs	7.6 (122)	35.4 (31)	2.5–25.27	22.7–75.81
Imaging	1.3 (123)	9.1 (12)	0.5–5.05	7.0–15.09
Radiotherapy	2.5 (94)	N/A	1.1–12.63	N/A
Surgery	12.6 (118)	252.7 (22)	2.5–37.27	252.7–379.05
Pathology	1.3 (125)	12.6 (19)	0.8–2.53	11.4–21.33
Chemotherapy	12.6 (131)	20.2 (33)	0.0–25.27	12.6–50.54
Inpatient service	12.6 (97)	25.3 (11)	1.3–25.27	16.4–138.98
All services	49.8 (151)	149.1 (53)	19.1–134.0	65.7–382.8

IQR: Interquartile range; USD: United States dollars; PCC: Tikur Anbessa Specialized Hospital-Radiation Centre; PHF: Private health care facilities; Diff: difference between PHF and PCC medians; N/A: Not applicable.

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Discussion

The main aims of this study were to assess how much BC patients spent on treatment and patients' WATP for BC treatment in Addis Ababa, Ethiopia. The main finding of this study was that costs were considerably high at PHF and three times higher at PCC. The median amounts that patients eventually paid for all services both at PCC and PHFs were six times higher than the median amounts they stated being willing and able to pay both in PCC and PHF. This indicates that these patients were forced to pay a higher amount for treatment of a life-threatening disease regardless of their WATP. Our findings show that the actual cost is more than what patients are willing and able to pay and more than their demand for health care services. This apparent contradiction is likely due to poorer report concerning what patients remember having spent in the past.

Table 4. Multivariable regression summary (dependent variable is WATP, in USD.

Variables	OR	95% CI (lower)	95% CI (upper)	p-value
Marital Status (Ref: Married, n = 86)				
Ex-married (n = 24)	**0.20**	**0.11**	**0.34**	**< 0.001**
Single (n = 11)	0.91	0.44	1.86	0.787
Occupation (Ref: Housewife, n = 46)				
Employed (n = 75)	0.71	0.46	1.12	0.142
Treatment duration (Ref: >2 years, n = 35)				
≤ 2 years (n = 86)	0.63	0.39	1.02	0.062
Higher monthly income (per 100 USD, n = 121)	**0.83**	**0.70**	**0.99**	**0.043**
Higher amount expended for BC treatment (per 100 USD, n = 121)	1.00	0.99	1.00	0.792
Higher Total Expenditure (per 100 USD, n = 121)	**1.43**	**1.09**	**1.89**	**0.010**
Higher Family Size (n = 121)	0.90	0.81	1.01	0.070
Increasing Educational Level (3 levels, n = 121)	**1.37**	**1.02**	**1.85**	**0.036**
Increasing Service Quality (3 levels, n = 121)	**1.34**	**1.04**	**1.72**	**0.026**
Higher Age (in years, n = 121)	1.00	0.97	1.02	0.708

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High absolute costs of treatment

Total costs for treatment were far higher than WATP. Even if patients were economically poor and dependent on others, they had to pay high amounts for their BC treatment. Due to the high cost of treatment, 56% of interviewed patients as well as their families were exposed to catastrophic health expenditure and financial distress. Studies conducted in the Mandura District, Western Ethiopia and in Dessie Referral Hospital, Northeast Ethiopia indicated that 22.5% and 64.2% patients were exposed to catastrophic health expenditure due to direct medical costs respectively, though the participants in those studies were not cancer patients [42,43]. A study conducted in Nigeria also reported that the mean OOP expenditure for BC diagnosis and management was 2,049 USD [44]. According to a study that assessed the prices of health care in 15 African countries, including Ethiopia, patients were compelled to sell their fixed and precious assets and to borrow to cover their health care expenditures. Moreover, a high proportion of patients were not able to get health care services, because they could not afford the costs [45,46]. Other patients paid 2,325 USD in Addis Ababa for cancer treatment [47], but 600 USD in Uganda and 2100 USD in Nigeria [48]. Our finding is also compatible with the theoretical definition of catastrophic health care because the following factors are met: the cost of health care service is covered OOP, (2) the household CTP is low, and (3) there is no prepayment system for risk accumulation [11]. WHO also declared that a household is said to be exposed to catastrophic health expenditure if the OOP expenditure on health is greater than or equal to 40% of the household's CTP [49]. In other words, the health expenditure is considered catastrophic if it is above the financial means of the household and this will lead the household to poverty or prevent the household from getting out of poverty. As indicated in the present study, most of the patients were exposed to catastrophic health expenditure because they incurred costs beyond their CTP. This shows that even though Ethiopian patients are in a lower economic category than patients in other countries, they spent similar amounts of money for their BC treatment. This underlines the high economic burden of BC on Ethiopian patients.

Patients estimated their personal WATP but eventually retrieved funding from a much larger extended family. Most of the patients were housewives who were financially dependent on income from their husbands, children, and relatives. These payments for the patients' BC treatment created financial distress not just for the patient but for the extended family as well. A study conducted in Nigeria indicated that about 78% of study participants with BC were not able to get treatment because of financial barriers they faced [50] and research conducted in Iran indicated that due to the cost of cancer treatment, patients' and their families' living conditions were worsened [11].

Comparison of private vs. public health care facilities

We observed that patients paid more at PHFs compared with PCC for similar treatment because PHFs are profit making institutions and provide treatment more quickly than PCC. For instance, a study conducted at PCC, Addis Ababa, Ethiopia and Yaoundé General Hospital, Cameroon revealed that patients with BC had long waiting times between their first consultation and surgery or other treatments [51,52]. In order to avoid treatment delays and to reduce the chance of the cancer progressing during the wait, patients preferred to pay more.

Various studies found that WATP can be influenced by factors such as age, education, income, dependency ratio/household size, attitude towards treatment, quality of health care services, locality rural/urban, and ability to pay [53]. In our study, we stated an association between average monthly income, education, service quality, and total expenditure and WATP of BC patients.

Increasing income was associated with decreased WATP. This finding was contrary to other studies that dealt with the WTP for BC treatment and other types of cancers because these studies focused on WTP only while our study focused on WATP [26,54,55]. Thus, we found that with increasing income, patients were more able but less willing to contribute to a higher amount of treatment costs. This result is consistent with studies conducted in Bangladesh, Sweden, and Ethiopia had found that the impact of income on WTP for medical care was negligible [56–59].

Educational level is a predictor of WATP. Studies showed that patients with higher educational level have better health literacy, resulting in them being better informed about the treatment and disease and more likely to be willing and able to pay for breast cancer treatment [29,60,61].

Perceived service quality was also associated with WATP. As patients perceived that the service quality is good, they were more willing and able to pay for their BC treatment. Especially economically better-off patients were willing and able to pay more for services that they believed were good. This is consistent with other studies that reported, patients who obtained good quality health care service were willing to pay more [53].

Total expenditure was also associated with WATP. This is because expenditure was directly related to income. This finding is consistent with the economic theory that a person's decision is a sequential process where the decision of whether to consume a particular commodity is followed by the choice of how much to consume. As health is a commodity and private good, this economic theory is also applicable to health care service, as we did in our study [62,63].

Potential limitations of the study

Patients were frequently unaware of the stage of their disease and staging might have changed during treatment. Thus, we did not consider the exact stages of BC of the interviewed patients and only differentiated between patients with up to 2 years and more than 2 years of total duration of treatment. Responses about actual household income had a high degree of uncertainty as income may vary greatly over time and estimating an average was difficult for respondents. Additionally, the definition of the household by participant varied and the respondents included closer or more distant relatives. Since the IQR of WATP only varied five-fold, we assume that the group of relatives with financial contributions to WATP were probably perceived as relatively similar among respondents.

Conclusion

The cost of BC treatment in Addis Ababa was beyond the patients' WATP and they were compelled to pay the required amount by asking for financial support from their relatives, including borrowing. Patients from public and private centres had similar disparities between WATP and actual costs indicating that eventually most patients and their families were exposed to catastrophic health expenditure. This indicated that the amount BC patients paid for their treatment was beyond their WATP, but they paid the amount indicated in this study because BC is life threating disease and patients and their families wanted to increase survival time. Thus, the contribution of this research is that decision makers in the health sector at all levels including at private health facilities should consider the WATP of BC patients when deciding on the fee for BC treatment.

Recommendations

Therefore, seeing these catastrophic expenditures, costs need to be limited and communicated early to the patients. Policy makers in the health sector should include BC treatment in both

social and community-based health insurances. Also, health facilities should ensure that their health care services fees are reasonable. Creative ways to co-finance from additional sources are needed to meet the objective of the WHO Global Breast Cancer Initiative assuring that 80% of the patients complete multimodal treatment.

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Declarations (Erklärungen)

(1) I declare that I have not undergone a doctoral procedure or started a doctorate at any other university.

(2) I declare that I have provided the information truthfully and that I have not submitted the scientific work to any other scientific institution for the purpose of obtaining an academic degree.

(3) Instead of taking an oath, I declare that I wrote the work independently and without outside help. All the rules of good scientific practice were observed; no other sources and tools were used than those indicated by me and the passages taken from the works used were identified as such, either verbatim or in content.

Addis Ababa, 03.06.2024 ==========

Place and date Signature

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