# Assessing household catastrophic total cost of Tuberculosis and their determinants in Egypt: A cohort prospective study

PI (1): Prof Mohsen Gadallah, Department of Community Medicine - Faculty of Medicine – Ain Shams University

PI (2): Dr. Wagdy Amin, General Director of Chest Department- Ministry of Health and Population (MOHP)

## Introduction:

Tuberculosis (TB) is a disease that disproportionately affects the poor. TB programs therefore need to ensure that the economically and socially TB patients do not face barriers that keep them from seeking treatment. By addressing barriers and reasons for delay to timely diagnosis and treatment by the National TB Program (NTP), costs to TB patients, particularly among the poor, can be effectively reduced [1].

Poor people have longer pathways to care and costs of accessing care are generally higher before than after diagnosis [2]. Out-of-pocket costs for public and private healthcare services may stand at the beginning of a spiral into poverty for many families and exacerbate the poverty of the already-poor. This situation has been termed the "the medical poverty trap" [3]. The post-2015 strategy aims for 'no affected families facing catastrophic costs due to TB' by 2025. Universal access to care and reducing the socioeconomic burden associated with tuberculosis are key objectives of the current World Health Organization (WHO) Stop-TB strategy. The WHO lists economic factors as one of four barriers to tuberculosis care [3].

In order to establish an evidence base for interventions that can contribute to TB-related poverty reduction, increase equity in accessing care, and increase TB case detection [4], there is need to document the full economic burden of TB care borne by patients across various settings in Africa with a standardized instrument. Importantly, about half of the financial burden is incurred before patients are diagnosed. Loss of income and direct expenses trigger a downward spiral whereby the patient is less able to complete treatment, more likely to have repeat episodes, and more likely to develop drug resistance resulting in more expensive and arduous treatment [5].

WHO is developing standard indicators and measurement approaches, including for the monitoring of a proposed post-2015 TB target of "no TB-affected family facing catastrophic cost due to TB by 2020". Measuring TB catastrophic cost could be useful overall indicator of equality in advancing towards Universal Health Coverage (UHC).

Many studies were done in Africa and Asia to assess the catastrophic cost of TB on patients and households. The incidence of total catastrophic cost of TB in Nigeria was

ranged between 37 to 44% [6-7]. In Asia, the reported catastrophic incidence in Indonesia was 36% [8] while in China was 66.8% [9].

In Egypt, there were no published studies that have estimated the total catastrophic costs of TB diagnosis and management on patients and households. Accordingly, conducting such study could be of value to assess the situation of economic constraints and impoverish impact of TB on patients and their households

## Study Objectives:

**General Objective**: To improve both equity and outcome of TB management through identifying the economic barriers that hinder the proper care provided for TB patients.

**Specific Objectives**:

1- To measure the incidence of total catastrophic cost of TB diagnosis and management
2- To identify the risk factors associated with the total catastrophic cost

**Public Health Impact**:

Egypt started the implementation of UHC in 2019 in few governorates. The results of this study will inform the policy makers about the situation of economic burden among patients with TB in Egypt. Moreover, the results of this study on a representative sample of the TB patients in Egypt is considered as evidence-base upon which subsequent interventions could be planned to increase equity in access to healthcare in Egypt . Also, the results may direct and guide the policy makers to concentrate on the significant determinants associated with the catastrophic cost.

## Subjects and Methods:

**Study design**: A cohort prospective study of the economic burden on individuals and their households, from the start of TB symptoms to the end of treatment in Egypt. This type of design minimized the recall bias and improves the accuracy of data. The study cohort included a sample of the newly diagnosed TB patients that registered in the National TB Program (NTP) during the first quarter of 2019. Study TB patients were followed up bi-monthly till the end of treatment regimen i.e. 6 months. In the first interview (contact) with the TB patients (visit 1); data were collected on the cost of pre-diagnosed period from the beginning of TB symptoms till the date of diagnosis. The second interview was held after two months (visit 2) which reflect the cost of treatment (direct and indirect) during the past two months (intensive phase). In a similar way the cost of treatment was captured in visit 3 (two months after the visit 2) and visit 4 (two

months after visit 3). The total cost is the sum of the costs of the four visits (pre-treatment and during the course of treatment).

**Study setting:**

Egypt is divided geographically into 3 sectors: Middle (Metropolitan area), North (Lower Egypt) and South (Upper Egypt). From North and South sectors two governorates were randomly selected (from North: Monufia and Alexandria while from South: Asyut and Aswan). From Middle sector; Cairo was randomly selected. There are 44 TBMUs in the selected governorates. A random sample of 21 TBMUs (7 out of 13 from Cairo, 5 out of 9 from Alexandria, 4 out of 9 from Monufia, and 5 out of 10 from Asyut were selected randomly. In Aswan we selected all TBMUs which are 3 in number. A proportional allocated sample from each governorate was calculated depending on the registered number of TB patients in 2018 i.e. a weighted proportional sample from each governorate and facility were considered during data collection.

**Study subjects:**

**Eligible patients:**

All consecutive new TB patients registered and attended TBMUs for starting the treatment were invited to join the study. All patients signed the informed consent.

**Ineligible patients**: Patients refused to sign the informed consent and children under 15-years-old without their guardian or refusal of guardian to give the consent. Also, retreated patients and Multi Drug Resistant (MDR) patients were excluded.

**Sampling method and sample size**

This is a cluster sample considering TBMU as a cluster. As there are 24 clusters from the five selected governorates, we retrieved around 10-20 patients per cluster. Consecutive consenting eligible patients had been interviewed at each study site until the required sample size reached. The sample size calculated for this study was 276 TB patients. The sample size was calculated using Epi Info version 7 software program [10]. The assumptions used for calculation were the followings: estimated Household Catastrophic cost rate of 30% (22%-38%), 95% confidence level, design effect of 2.0, and dropout rate of 10%. The assumptions based on results published recently from countries similar to Egypt. This sample is considered as a national sample of newly diagnosed TB patients.

**Data collection tool:**

A standardized questionnaire from the Poverty sub-working group of the Stop TB Partnership titled: ‘‘Tool to Estimate (TB) Patient’s Costs’’ was be used [1] after some modifications to costume the Egyptian culture and the objectives of the study.

Interviews had been carried out by trained healthcare workers with previous experience in interviewing TB patients. Interview was held at TBMUs where patients receive TB care. The interview was taken in a separate and ventilated room to ensure that there were no disturbances and to preserve patients' privacy.
The tool was translated from English to Arabic by the PI and senior Co-investigator with fluent English speaking and writing. Then retranslated from Arabic to English by another two experts staff in public health and epidemiology not participated in the study. The questionnaire was piloted on 20 TB patients in some TBMUs in nearby governorate not selected for implementing the study.

**Training of Data Collectors and field supervisors:**
Data collectors (interviewers) and the field supervisors were trained for 2 full days about the objectives, methodology of the study and the contents of the questionnaire.

**Study variables/indicators definitions:**

**Catastrophic total costs due to TB:** The catastrophic total cost (direct, indirect coping and guardian costs) is considered if the total household cost from the onset of symptoms to the end of TB treatment exceeds 20% of the total annual income of the household. For sensitivity analyses; we used different cutoff percentages as 10%, 30% of the total annual income.

**Catastrophic cost incidence (%):**

Number of TB patients/households with catastrophic cost / Total number of study TB patients multiplied by 100

**Direct costs**: are out-of-pocket (OOP) costs linked to seeking diagnosis and treatment including medical expenses, fees, transport, accommodation, food expenditures and other costs.

**Indirect costs**: are patients' lost incomes due to illness.

**Guardian cost**: The costs incurred by family members looking after the patient during care. For each guardian, both direct and indirect costs were considered.

**Coping:** Costs incurred by patients who attempted to cope with the costs of TB care by: borrowing money or selling their assets.

**Household cost**: Household costs for each patient is the sum of patient direct, indirect, coping, and guardian costs.

**Pre-diagnosis/diagnosis cost**: The costs incurred in the period between the onset of symptoms up until the diagnosis of TB.

**Annual income of the patient's household**: The annual income will be estimated from the average monthly income reported from the patient. This was calculated from the monthly income before TB symptoms, after diagnosis and at the end of treatment.

**Monitoring, supervision and quality control**

The questionnaire of the study was tested in a pilot study among sample of 20 patients attended a TBU in one governorate nearby Cairo. Also, strict supervision of data collection was carried on all sites of the study. The survey principal investigators and co-investigators conducted in a schedule time field supervisions. The team leader at each facility checked all questionnaires at the end of each day. Moreover, revising all questionnaires at central level was done by the study team and the statistician for completeness and accuracy of data.

**Data entry and data privacy**

All data entered in a private PC computer with ID code given to each questionnaire to replace the names of the patients to keep the privacy of the participated patients. All questionnaires were kept in a private place after data entry. Excel program was used for data entry and IBM-SPSS version 21 was used for statistical analysis. The descriptive statistical analysis of the cost of TB treatment included mean, standard deviation, median, interquartile range, frequency, percentage, 95% confidence interval. For analytical statistical analysis, bivariate analysis using chi square test was done first then variables expressed p value <0.25 were included in the multivariable analysis using binary logistic regression. P value < 0.05 was considered as statistically significant.

## Results:

**Sociodemographic Characteristics of TB patients**:

Out of 276 newly TB patients interviewed during the first quarter of 2018, only 257 were with complete records. The characteristics of the study cohort (N=257) were displayed in table-1. The mean value (± SD) of age of those with complete records was 38.3 (14.8) and around one quarter of patients aged ≥ 50 years old. Among this cohort males were more encountered (61.9%), 58.8% were married, 22.6% were illiterate. Regarding the employment status, one quarter of the study sample was affiliated to governmental organizations with a regular monthly income, 55.3% were freelancer or working in private sectors and around one fifth were unemployment (Jobless).

The majority of TB patients live in urban governorates as the majority of the sample subjects were retrieved from Cairo city and the crowding index for 78.6% of TB patients was 1-2 persons/room (table-1).

Regarding monthly income and all costs incurred by the patients, we collected the data in Egyptian Pound (EP) then converted the Egyptian pound to US $ (One US$ = 16.5 EP). The mean (±SD) of monthly income was 119 US$ (± 71) while the median value (IQR) was 109 US$ (61 – 152). Household earning below 1000 Egyptian pound per month (those in the first quintile of the monthly income) was considered as poor. Around 25%

of the participants were poor and 11.3% reported coping costs by borrowed money or sold their assets.

**TB episode cost:**

Table-2 shows the total household/ Patients' costs incurred by TB patients during TB episode. The median (IQR) of the out-of-pocket payment for total direct (from staring symptoms to the end of treatment) was 61 US$ (31 – 108 US$). The direct medical costs included consultation fees, drugs, lab tests, X-ray examinations while the direct non-medical costs included costs of travels, food, and accommodation for patients' and guardian's, plus any special nutritional/food for patients. The median value of the direct medical costs amounted to 43.9 % (61/139) of the net total costs of TB and accounted to 4.7% of the total median value of annual household income. The pre-diagnosis direct cost accounted for more than 50% of the total direct costs (34/61, 55.7%).

Regarding indirect costs, the median (IQR) of the total indirect costs was 61 US$ (0 – 145 US$). The indirect costs included household income loss reported by TB patients and their guardians. The indirect costs were calculated at different study periods i.e. pre-diagnosis, intensive phase of treatment and two times during the continuation phase. AS direct cost, the indirect cost accounted to 43.9% of the net total costs of TB episode.

Only 29 patients reported coping strategies (borrowed money or sold assets) to cover the expenditures of TB. The mean value of coping costs was 9 US$ and the median was zero for the whole sample while amongst those reported coping (29 patients), the mean was 80 US$ and the median (IQR) cost was 61 US$ (52 – 106 US$).

The median (IQR) of welfare payment (donation) by governmental sources and Non-Governmental Organizations (NGOs) was 12 US$ (0 – 29 US$). There was a trivial amount of money given every month to poor TB patients which given to them during the follow-up visits at TBMUs.

The total cost incurred by TB patients and their guardians was 155 which accounted to 11.8% of the median annual total household income before TB. However, after subtracting the amount of donation received by the TB patients, the total cost decreased to 139 US$ which resemble 10.6% of the total annual income.

**Distribution of household total catastrophic cost**

In table-3, household total catastrophic cost rate was considered at different cutoff points and methods. At 20% threshold, the Incidence of the total Catastrophic Cost (ICC) (direct and indirect) among the study sample was 24.1% and when using 30% the incidence declined markedly down to 6.6%. Also, when using the other method of calculating the incidence of catastrophic cost (if direct cost of TB episode exceed 10% of pre-symptomatic annual income), the rate was 22.6%. Furthermore, the incidence of

catastrophic cost was analyzed across study variables we used only the first method that recommended from WHO (table 4). The results showed that younger age groups less than 30 years showed higher significant ICC than those 50 years and above (Crude OR=2.37, 95%CI= 1.05 - 5.39). However, there were no significant differences between males and females as well as current marital status. ICC showed more or less similar rates among different grades of education.

Compared to the ICC among patients affiliated to governmental organizations with stable monthly income, patients working as a free lancers or in private sectors experienced higher ICC (cOR=2.72, 95%CI=1.03 – 5.04). Also, crowding index was significantly associated with ICC as patients living in houses with crowding index more than 2 persons per room showed an ICC of 36.4% compared to 20.8% for those with 1-2 persons/room.

There was no significant difference in ICC among patients living in urban governorates versus urban-rural governorates. Poor patients experienced higher ICC (33.3%) than non-poor or less poor patients (21.1%).

The highest incidence of catastrophic total cost was reported among those with coping strategies (55.2%) compared to 20.2% among non-coping patients.

**Determinants of the Incidence of Total Catastrophic Cost:**

In order to identify the determinants variables associated with higher ICC, we used multivariable logistic regression model (table 5). The variables that showed p value <0.25 in the bivariate analyses (table 3) were entered in the model at step-1 then a backward stepwise method was used to adjust for confounding variables. The variables retained in the final step of the model that significantly predict the high ICC were: younger age less than 30 years (adj. OR=2.62, 95%CI=1.07 – 6.41), those living with crowding index more than 2 persons per room (adj. OR=2.32, 95%CI=1.18 – 4.58), poor patients (adj. OR=2.06, 95%CI= 1.06 – 3.98) and TB patients with coping strategies (adj. OR=5.13, 95%CI= 2.26 – 11.68).

**Table (1) Characteristics of study TB patients (N=257)**

| Variables | Category | No. | % |
|---|---|---|---|
| Age Groups | <30 | 83 | 32.3 |
| | 30 - 49 | 109 | 42.4 |
| | ≥ 50 | 65 | 25.3 |
| Gender | Male | 159 | 61.9 |
| | Female | 98 | 38.1 |
| Current Marital Status | Single | 89 | 34.6 |
| | Married | 151 | 58.8 |
| | Divorced/Widow | 17 | 6.6 |
| Education levels | Illiterate | 58 | 22.6 |
| | Primary-Secondary | 158 | 61.5 |
| | University | 41 | 16.0 |
| Employment | Governmental | 63 | 24.5 |
| | Free Lancer / Private | 142 | 55.3 |
| | Jobless | 52 | 20.2 |
| Crowding Index | 1-2 persons/room | 202 | 78.6 |
| | > 2 persons/room | 55 | 21.4 |
| Urban/Rural Governorates | Urban Governorates | 212 | 82.5 |
| | Urban/Rural Governorates | 45 | 17.5 |
| Type of TB | Pulmonary | 171 | 66.5 |
| | Extra-Pulmonary | 86 | 33.5 |
| Income (Poverty status) | Poor (<61 US $) | 63 | 24.5 |
| | Non-Poor | 194 | 75.5 |
| Coping | No | 228 | 88.7 |
| | Yes | 29 | 11.3 |

US$= 16.5 Egyptian Pound (average in 2019)

**Table (2): Total Household/ Patients' costs incurred by TB patients during the pre-diagnosis, intensive phase and continuation phase**

| | Type of cost | Mean Cost US$ | Median Cost US$ | IQR [US$] | |
|---|---|---|---|---|---|
| | | | | 25th | 75th |
| Pre-diagnostic period (visit 1) | Direct costs | 56 | 34 | 12 | 72 |
| | Indirect costs | 21 | 0 | 0 | 30 |
| Intensive Phase period (2 months after diagnosis (visit 2) | Direct costs | 14 | 3 | 2 | 8 |
| | Indirect costs | 27 | 13 | 0 | 36 |
| Continuation Phase ( four months after diagnosis (visit 3) | Direct costs | 10 | 6 | 2 | 12 |
| | Indirect costs | 29 | 15 | 0 | 42 |
| Continuation Phase (six - seven months after diagnosis – visit 4) | Direct costs | 9 | 4 | 2 | 9 |
| | Indirect costs | 32 | 18 | 0 | 42 |
| **Total direct costs of HH** (pre-diagnosis, post diagnosis) | Sum of all direct costs | 89 | 61 | 31 | 108 |
| **Total indirect costs of HH** (pre-diagnosis, post diagnosis) | Sum of all indirect costs | 109 | 61 | 0 | 145 |
| Total Cost of HH (Direct and indirect) | Sum of all direct and indirect costs | 198 | 153 | 67 | 239 |
| Coping costs (borrowing and selling) | Coping | 9 | 0.0 | 0 | 0 |
| Donation from all sources | Donation/welfare payment | 13 | 12 | 0 | 29 |
| Total Cost of HH of Direct, indirect and coping | Sum of direct, indirect costs and coping | 207 | 155 | 69 | 261 |
| Net total Cost of HH (direct, indirect and coping minus donation ) | Sum of all direct, indirect costs and coping minus donation | 194 | **139** | 60 | 242 |
| Annual total household income before TB | Pre-symptomatic | 1430 | 1309 | 218 | 5818 |

IQR= Inter quartile range. Direct and indirect costs included the costs of the guardians

**Table (3): Incidence of Catastrophic cost of TB using different cutoff points**

| | Incidence of household Total catastrophic cost |
|---|---|
| If total cost of TB episode exceed 20% of pre-symptomatic annual income | **24.1%** |
| If direct cost of TB episode exceed 10% of pre-symptomatic annual income | **22.6%** |
| If total cost of TB episode exceed 30% of pre-symptomatic annual income | **6.6%** |

**Table (4) Distribution of catastrophic total household costs among TB patients according to study variables**

| Variables | Category | Total Catastrophic HH Cost | | Statistics | | |
|---|---|---|---|---|---|---|
| | | Yes | % | P | cOR | 95% CI |
| Age Groups | <30 (n=83) | 25 | 30.1% | 0.039 | 2.37 | 1.05-5.39 |
| | 30 – 49 (n=109) | 27 | 24.8% | 0.147 | 1.81 | 0.81-4.04 |
| | ≥ 50 (n=65) ® | 10 | 15.4% | - | - | - |
| Gender | Male (n=159) | 43 | 27.0% | 0.163 | 0.65 | 0.35 – 1.20 |
| | Female (n= 98) ® | 19 | 19.4% | | | |
| Current Marital Status | Single (n=89) | 23 | 25.8% | 0.642 | 1.16 | 0.63 -2.12 |
| | Married (n=151) ® | 35 | 23.2% | - | - | - |
| | Divorced/Widow (n=17) | 4 | 23.5% | 0.974 | 1.02 | 0.31 -1.33 |
| Education levels | Illiterate (n=48) | 14 | 24.1% | 0.800 | 1.13 | 0.44 -2.94 |
| | Primary-Secondary (n=158) | 39 | 24.7% | 0.716 | 1.17 | 0.51 -2.65 |
| | University (n=41) ® | 9 | 22.0% | - | - | - |
| Employment | Governmental (n=63) ® | 9 | 14.3% | - | - | - |
| | Free Lancer / Private (n=142) | 39 | 27.5% | 0.043 | 2.72 | 1.03-5.04 |
| | Jobless (n= 52) | 14 | 26.9% | 0.096 | 2.21 | 0.87 -5.63 |
| Crowding Index | 1-2 persons/room (n=202) ® | 42 | 20.8% | 0.017 | 2.18 | 1.14- 4.15 |
| | > 2 persons/room (n=65) | 20 | 36.4% | | | |
| Governorates | Only Urban (n=212) ® | 48 | 22.6% | 0.228 | 1.54 | 0.76- 3.13 |
| | Mixed Urban/Rural (n=45) | 14 | 31.1% | | | |
| Type of TB | Pulmonary (n=171) ® | 41 | 24.0% | 0.936 | 1.02 | 0.56 – 1.88 |
| | Extra-Pulmonary (n=86) | 21 | 24.4% | | | |
| Income (Poverty status) | Non-Poor (n=194) ® | 41 | 21.1% | 0.049 | 1.87 | 1.00- 3.49 |
| | Poor (n=63) (<61 US $) | 21 | 33.3% | | | |
| Coping | No (n=228) ® | 46 | 20.2 | <0.001 | 4.87 | 3.19-10.84 |
| | Yes (n=29) | 16 | 55.2 | | | |

cOR= Crude Odds Ratio

US$= 16.5 Egyptian Pound (average in 2019)

**Table (5) Predictor factors associated with high catastrophic total household costs among TB patients using multivariable logistic regression model**

| Variables | Category | Logistic regression analysis | | |
|---|---|---|---|---|
| | | P | Adjusted OR (adj. OR) | 95% CI |
| Age Groups | <30 | 0.035 | 2.62 | 1.07 – 6.41 |
| | 30 – 49 | 0.376 | 1.48 | 0.62 - 6.56 |
| | ≥ 50 ® | - | - | - |
| Gender | Male | 0.452 | 0.77 | 0.38 – 1.53 |
| | Female ® | | | |
| Employment | Governmental ® | - | - | - |
| | Free Lancer / Private | 0.076 | 2.17 | 0.92 - 5.10 |
| | Jobless | 0.441 | 1.54 | 0.51 - 4.63 |
| Crowding Index | 1-2 persons/room ® | | | |
| | > 2 persons/room | 0.015 | 2.32 | 1.18 - 4.58 |
| Governorates | Only Urban ® | 0.078 | 2.03 | 0.92- 4.47 |
| | Mixed Urban/Rural | | | |
| Income (Poverty status) | Non-Poor ® | 0.032 | 2.06 | 1.06 – 3.98 |
| | Poor (<61 US $) | | | |
| Coping | No ® | <0.001 | 5.13 | 2.26 - 11.68 |
| | Yes | | | |

Adj. OR= Adjusted Odds Ratio
US$= 16.5 Egyptian Pound (average in 2019)

## Discussion

This study is considered the first study done in Egypt to assess the economic burden of TB diagnosis and treatment. In Egypt, the Ministry of Health and Population provides free services (diagnosis, drugs and lab investigations). However, the incidence of household total catastrophic cost in this study was 24.1% i.e. one out of four newly diagnosed TB patients confronted catastrophic cost during the TB episode. When we used other cutoff threshold and method (direct cost exceed 10% of the annual income), the ICC was 22.6%. Comparison with studies that used percentage of direct costs exceeding 10% of the household income, a similar incidence of catastrophic health expenditure was reported in South Africa [(11)] while in Nigeria higher incidence (44%) was reported [[6]] and much higher rates were reported in China (67%) and Benin (78.1%) [(9,12)]. However, comparison with other studies that adopt WHO method of total catastrophic health expenditure of at least 20% from the annual income, our finding (24.1%) was lower than what reported in some Asian countries [(8,13-14)] e.g. Indonesia

(36%), Puducherry-India (32%), Viet Nam (63%). Moreover, our finding was lower than the corresponding figures reported in other studies in Africa [15-17] e.g. Uganda (53.1%), South Africa (28%), and Kenya (26.5%). Although all the above studies including our study, the total catastrophic irrespective to the method of calculation are considered high and posing a high economic burden on TB patients and their families as most of TB patients in developing countries are poor.

More than 50% of the total direct cost was incurred during the period between onset of symptoms and time of TB diagnosis. This finding is in agreement with other studies in Africa [7,11] and Asia [9,13]. The longer the pre-diagnosis period the higher cost incurred by TB patients before treatment. Lack of public awareness about the symptoms of TB is one of the reasons behind long delay until TB diagnosis and increased household impoverishment. Total Direct and indirect costs were more or less similar in our study. However, direct cost was much higher than indirect cost incurred by TB in the pre-diagnosis period while the reverse occurred during the intensive and continuation phases. Similar finding was reported in Viet Nam [14]. In contrary to our finding, Ukawaja et al. in Nigeria reported much higher indirect cost than direct cost either in pre-diagnosis period or post-diagnosis [7]. Moreover, a very low percentage of indirect cost was reported by Sarin et al in Delhi-India which may return to the availability of TB management units near the work or residence areas of the TB patients [18]. The presence of DOT centers near the houses and work of TB patients have a positive impact on the travel by decreasing both time and non-medical costs [18]. There were marked variations between different studies regarding the ratio of direct to indirect costs. These differences may attributed to the method used to calculate the indirect costs, financial and welfare policies toward TB management and the role of NGOs for supporting the poor patients.

Analyzing the determinants of high catastrophic total cost, the results showed that younger age less than 30 years incurred catastrophic total cost more than double the cost among elder group. A similar result was found in Nigeria [7] and India [13] while in contrary a study in China reported more cost among elderly people [9]. Many other studies reported no association between age and catastrophic cost [6,8,12,16,17,18]. Younger TB patients are more likely to be affected financially and economically due to long journey of the TB episode which end by decreasing in the income in particularly among those working in private sectors or working as free- lancer with low monthly income.

In this study males experienced more catastrophic cost but after adjustment for other factors, this association disappeared. In majority of studies reported high incur cost among males but insignificant [8-9,12,15,17] while few studies reported significant high incur catastrophic cost among males [6-7,18].

As reported in some studies [7-9,12,17], our findings revealed no association between education level and catastrophic total cost. Moreover, employment status was not a

determinant for household total catastrophic cost. There was no consensus in the studies that analyzed the association between education level and catastrophic cost, as few studies report higher costs among educated patients [6,18] while other reported the reverse i.e. higher incur cost among non-educated [9].

Patients and household who are living in house with crowding index of more than 2 were more likely to incur more household total catastrophic cost. Poor families with TB patients are characterized by being large family size which add more economic burden and most likely expose them to high catastrophic cost. However, in a study in China reported that large families were less likely to expose to high catastrophic cost which may return to more earners in the family [9].

Our findings showed the role of poverty in increasing the rate of total catastrophic cost. Poor TB patients were more likely to incur higher incidence of total catastrophic cost than non-poor. There is a general consensus about this finding as almost all studies reported similar finding.

Our finding emphasized the important of coping as a determinant factor behind high household total catastrophic cost. Those with coping strategies were 5 times more likely to experience total catastrophic cost. Similar finding was reported in many studies.

**Limitations of the study:** This study has some limitations as it included only newly discovered TB patients and excluded re-treated and multidrug resistant TB patients. Recall bias is one of the characteristics of studies concerned with income and cost of treatment. However, we tried to minimize this bias by conducting a prospective cohort study and interviewed TB patients at short intervals during the treatment period and we used the structured WHO questionnaire. Also, the study retrieved TB patients from only 5 governorates out of 27 in the country although we selected randomly governorates that represent the different geographical areas of Egypt.

**Conclusions**: This is the first study concerned with the total catastrophic cost of TB in Egypt. The results revealed one out of each four newly TB patients experienced a catastrophic cost. The main drivers behind high cost were poor patients with low monthly income and younger age male patients were more prone to high catastrophic cost specially, if they were the only breadwinners of the family.

**Policy recommendations:** The determinants identified from this study should considered by MOHP during implementing the universal healthcare coverage by engaging different concerned ministries as the social and finance, to mitigate the economic and financial burden of families affected by TB. The Ministry of Health and Population should be collaborated with NGOs to put a plan of social protection system for TB poor patients to cover their non-medical costs.

## Acknowledgements

The authors of this research thank all TB patients and their guardians for their agreement and valuable times spent during the interviews. Also, we thank all team work staff (interviewers, field supervisors, data entry) for their great efforts to conduct this study.

### Funding

This research received financial support from EMRO/TDR Small Grant Scheme for Implementation Research in Infectious Diseases of Poverty"- 2018

## References:

1. World Health Organization. Addressing poverty in TB control. WHO report 2005. WHO/HTM/TB/2005.352. Geneva, Switzerland: WHO, 2005. Available at http://whqlibdoc.who.int/hq/2005/ WHO_HTM_TB_2005.352.pdf. Accessed May 2018

2. Kamolratanakul P, Sawert H, Kongsin S, Lertmaharit S, Sriwongsa J, et al. Economic impact of tuberculosis at the household level. Int J Tuberc Lung Dis.1999; 3: 596–602.

3. Dahlgren & Whitehead. Concepts and principles for tackling social inequities in health. WHO EURO (2006). http://www.euro.who.int/document/e89383.pdf Accessed 2018 May

4. Russell S: The economic burden of illness for households in developing countries: a review of studies focusing on malaria, tuberculosis, and human immunodeficiency virus/acquired immunodeficiency syndrome. Am J Trop Med Hyg.2004; 71 (Suppl 2): 147–155.

5. Ukwaja KN, Modebe O, Igwenyi C, Alobu I. The economic burden of tuberculosis care for patients and households in Africa: a systematic review. Int J Tuberc Lung Dis. 2012;16: 733–739.

6. Ukwaja KN, Alobu , Abimbola S, Hopewell PC. Household catastrophic payments for tuberculosis care in Nigeria: incidence, determinants, and policy implications for universal health coverage. Infectious Diseases of poverty 2013, 2:21

7. Ukwaja, Alobu I , lgwenyi C, Hopewell PC. The High Cost of Free Tuberculosis Services: Patient and Household Costs Associated with Tuberculosis Care in Ebonyi State, Nigeria. PLoS ONE 8(8): e73134. doi:10.1371/journal.pone.0073134

8. Fuady A, Houweling T A J, Mansyur M, Richardus J H. Catastrophic total costs in tuberculosis-affected households and their determinants since Indonesia's implementation of universal health coverage. Infectious Diseases of Poverty.2018; 7:3

9. Zhou C, Long Q, Chen J, Xiang L, Li Q, Tang S, Huang F, Sun Q and Lucas H. Factors that determine catastrophic expenditure for tuberculosis care: a patient survey in China. Infectious Diseases of Poverty (2016) 5:6

10. Epi Info version 7.0 for Windows. CDC- Atlanta – USA.
Available at: https://www.cdc.gov/epiinfo/support/downloads.html . Accessed May 2018

11- Foster N, Vasall A, Cleary S, Cunnama L, Churchyard G. Sinanovis E. The economic burden of TB diagnosis and treatment in South Africa. Soc Sci Med. 2015; 130:42-50

12- Laokri S1, Dramaix-Wilmet M, Kassa F, Anagonou S, Dujardin B. Assessing the economic burden of illness for tuberculosis patients in Benin: determinants and consequences of catastrophic health expenditures and inequities. Trop Med Int Health. 2014 Oct;19(10):1249-58

13- Prasanna T, Jeyashree K, Chinnakali P, Bahurupi Y, Vasudevan K, Das M

Catastrophic costs of tuberculosis care: a mixed methods study from Puducherry, India. Glob Health Action.2018. 11(1):1477493.

14- Nhung NV, Hoa NB, Anh NT, Anh LTN, Siroka A, Lönnroth K, Garcia Baena I

Measuring catastrophic costs due to tuberculosis in Viet Nam. Int J Tuberc Lung Dis. 2018 Sep 1;22(9):983-990

15- Batte C, Kirenga B, Katamba A, Baena IG. Catastrophic total costs due to tuberculosis among affected households in Uganda; prevalence, drivers and policy implications. European Respiratory Journal 2019; 54: Suppl. 63, PA2793.

16- Stracker N, Hanrahan C, Mmolawa L, Nonyane B, Tampi R, Tucker A, West N, Lebina L, Martinson N, Dowdy D. Risk factors for catastrophic costs associated with tuberculosis in rural South Africa. Int J Tuberc Lung Dis. 2019 June 01; 23(6): 756–763

17- Republic of Kenya – Ministry of Health. First Kenya Tuberculosis patient cost survey 2017. Available at: https://www.chskenya.org/wp-content/uploads/2018/07/TB-Patient-Cost-Survey-2018.pdf. Accessed December 2019.

18- Sarin R, Vohra V, Singla N, Thomas B, Krishnan R, Muniyandi M.
Identifying costs contributing to catastrophic expenditure among TB patients registered under R NTCP in Delhi metro city in India. Indian J Tuberc. 2019 Jan;66(1):150-157