Title: Smartphone based self reporting system for the assessment of catastrophic health expenditures - a participatory approach to household surveys

Other Technical Details(EMR/2017/001864/HS)

1. Origin of the Proposal:

When healthcare expenses are large relative to the household's financial resources, it leads to disruption in the living standards of the household and is considered as catastrophic health expenditure(1). Out-of-pocket payments for healthcare is the single largest predictor of catastrophic health expenditures(2). Because of this, the distribution of out-of-pocket payments have been extensively examined to make inferences regarding catastrophic health expenditures(3–8) and to identify household and contextual predictors of catastrophic health expenditures. Current sources for such analyses are cross-sectional data drawn from large sample surveys of households(9–11). However, it has been demonstrated that data from sample surveys exhibit significant measurement errors and biases which threaten the internal validity of estimates(12–15). Further, they are less suitable for detection of households' vulnerability to health shocks as such assessments involve tracking or monitoring changes in expenditure patterns, in particular, after an illness or health shock. Furthermore, large surveys have a long turnaround time between the collection of survey data to entry, processing and availability of results. Hence, there is a need for more valid, rapid, and timely measurement applications to address some of the limitations with existing approaches to the assessment of catastrophic health expenditure.

2. Review of status of Research and Development in the subject

2.1 International Status:

Measuring households' healthcare expenditure is a challenging task which requires gathering large sets of reliable data to effectively gauge validity in forming key outcome indicators and in understanding differences between populations. Data from large scale international surveys such as Living Standards Measurement Surveys (LSMS), World Health Surveys (WHS), Consumer Expenditure Surveys (CES), Income and Expenditure Surveys (IES) and Household Budget Surveys (HBS) play a major role in understanding the distribution of households' total and healthcare expenditure and in formulation of indicators. For instance, a pooled multi-country analysis of surveys from 89 countries indicate that **globally 150 million people suffer financial catastrophe each year** as a result of out-of-pocket payments for accessing healthcare – defined as an expenditure of more than 40% of non-food household expenditure or 10% of overall expenditure(3). Another analysis of healthcare expenditures from 15 African countries revealed that around 30% of households financed healthcare expenditures by borrowing and selling assets(16). Among Asian countries, the **overall prevalence of poverty estimates increased by 14% when out-**

of-pocket payments for health care were taken into account for analysis(4). Together these findings indicate that out-of-pocket payment is the predominant form of healthcare financing in many poorer parts of the world and tends to correlate strongly with incidence of catastrophic and impoverishing healthcare expenditures. This intricate link of health with poverty has led to the need for mechanisms of protection against disease-induced poverty which are now a target goal for global health policy(17). However, it is worth noting the concerns regarding accuracy of expenditure data reported in cross-sectional household surveys. Previous studies have assessed the ability of households' to remember a multitude of expenditure types and its potential impact in biasing the derived aggregate outcome indicators(12). Experiments using households from the Ghanaian Living Standards Surveys, found that for 13 frequently purchased items, reported expenditure fell at an average of 2.9 percent per additional day in the recall period(15). This leads to a downward bias in estimates as recall period increases with increasing likelihood for recall bias. On the other hand, shorter recall periods are affected by 'telescoping' whereby respondents include events or expenditure that are larger, but likely to have happened before the beginning of the recall period, which could lead to an upward bias in estimates. Accommodating these findings, the Consumer Expenditure Survey in the U.S has changed its cross-sectional design with an annual recall period to a diary method. It introduced diaries to one set of households and a repeated survey to a different set of households. The results from this field experiment confirmed previous evidence about the telescoping and recall bias.

This set of investigations led to the exploration of diaries as an alternative approach to household surveys. Here, the respondent is asked to record, usually daily, expenditures in an account book. Participants make records as events occur or close to that time and hence eliminate the need for respondents to rely on their memory, which is likely to remove associated biases compared with cross-sectional tools for data collection(18). This approach has been used extensively in many fields of research, including, nutrition, sleep, lifestyle and health research(19–23). Most of the current information on use of diaries in household surveys come from the Living Standards Measurement Surveys (LSMS) by the World Bank conducted in several West African countries(24). While diaries shift the burden of response on to the respondents and allow households to participate in generation of survey data in a more convenient frame (in terms of place and time), the effect of this shift is unclear. Existing literature on experimental use of diaries in multiple settings reveal expenditures reported were considerably greater for the diary than for the interview. This pattern was consistent for different subgroups of expenditures and was partly attributed to shorter recall and greater disaggregation of the items with the diary approach(25,26). However, evidence from developed countries suggest that diaries cause respondents to drop-out, with declining rates of participation over time. This is attributed to mental fatigue as the novelty of diary-keeping wears off with time. While diaries produce better results, it is unclear whether current paper and pencil based measurement platform for diaries will help in consistent response rates as this might require a real-time monitoring systems for tracking compliance with timely entries.

Smartphones have become the natural point of engagement with digital data connections being more frequent than voice calls in some parts of the world (27). Recently, smartphone based surveys have increasingly been used to conduct studies and collect objective as well as subjective data(28,29). With the alert and push notification systems, this approach provides excellent tools for information and for reminders to the participant to improve compliance rates. It has resulted in higher participant compliance and timeliness of response compared to the paper based diary-surveys and use of such novel technologies may improve measurement approaches(30)

2.2 **National Status:**

India's total health expenditure, including insurance and out-of pocket expenditure, is 4.7 percent of its GDP – below the average of low-income countries (5.4%) and far below the world (8.5%). With Government expenditure only around 1.4% of GDP, India ranks among the countries with lowest relative public expenditure on health. Currently, the private sector plays a major role driven by out-of-pocket payments. Approximately 70% of healthcare is financed through out-of-pocket payments by the households at the time and point of use of healthcare – a proportion much larger than the 25-50% range in several developing and developed countries(31). Given the low level of government spending, the public sector share of outpatient visits and hospitalizations is only about 20% and 40%, respectively(32).

Most past analysis of households' health expenditures used data from National Sample Survey(NSS)(10). The NSS is a multi-stage, multi-purpose, cross-sectional and nationally representative sample of urban and rural households from different socio-economic strata. It is conducted by the National Sample Survey Organization (NSSO), under the Ministry of Statistics by the Government of India annually and 2014 was the 71st round of survey. The last survey was carried out for a period of six months from a total of ~65,000 households. Findings from the most recent survey (2014) indicate about 9% and 12% reported ailments during a 15 day reference period in rural and urban populations, respectively(33). For outpatient visits, estimates of total expenditure incurred per treated person were Rs.569 in rural and Rs.685 in urban populations. Similar total expenditures for hospitalized treatments were ~Rs.15,000 in rural and ~Rs.24,500 in urban populations. For poor households who report a household monthly expenditure below Rs.800 in rural and Rs.1200 in urban, this leads to a catastrophic financial burden. Estimates from past studies indicate that, on average, 35% of hospitalizations caused the affected households to be pushed into poverty. This translates, in real terms, to around 60 million people (7% of the population) falling below the poverty line, per year because of health related expenditure (34). However, with concerns on data quality, it is unclear how reliable the outcome indicators are. In addition, the current survey format leads to significant delays in producing datasets ready for further analysis. Together, this results in indicators which are highly variable, uncertain and outdated and serves as an obstacle to formulate key decisions.

With 1005 million subscribers, India has the second largest mobile subscription base in the world. According to a recent report(35), there were ~ 300 million smart phone users in India with a growth rate of 54% and TRAI sees a significant penetration of smart phones in rural areas as well. Past studies have tested the use of smart phones as a platform for delivering health services, promotional information and act as an assistive tool for public health practitioners. While multiple studies have tested whether interventions delivered through smart phones were effective, especially in the domain of social and behavior change(36–39), evidence on its potential to obtain real-time survey data is limited.

2.3 **Importance of the proposed project in the context of current status**

Methodological studies have identified two main problems with cross-sectional household sample surveys. First, sample surveys are retrospective and depend on the ability of the participants' episodic memory to recall expenditures incurred over a period of time. With length of time, the recall of expenditures decline and memory reconstruction tend to be heavily tilted towards the peak expenditure and expenditure occurring during the end of month or close to the time of evaluation(40–42). Second, cross-sectional surveys do not allow assessment of how a household alters its consumption patterns after an illness, or infer trajectories and hence **the actual impact of illness on household consumption is not known**. While alternatives to improve the accuracy of estimates has not been clear, studies have found reasonable evidence for the use of prospective diaries for recording households' expenditures to minimize limitations inherent in cross-sectional surveys(18,23,42).

Diaries are prospective in nature and since event-related information are recorded close in time to their actual occurrence, it is expected to be free of measurement error and better suited to infer change in patterns of expenditure(18). Though the inherent advantages of using a diary approach is well recognized, it has been used only in few isolated areas of research(43). Research studies which have utilized the diary approach indicate its utility in gaining knowledge of underlying processes, but mention significant problems relating to completeness and compliance. Diaries require considerable effort and time from participants and if length of participation is long, then it leads to mental fatigue, which may prompt participants to discontinue. Participants might also indulge either in backfilling or forward filling of entries so as avoid missing entries. Thus, in the current the paper based diary format, it is difficult to track compliance or completeness without intensive monitoring in person or by appropriate use of technology.

While current research in use of technology focuses on mobile phone based SMS texting or voice-based programs (40,41), the potential of smart phones to engage populations in a mutual exchange of information is relatively new. With the rapid spread of smart phone technology and applications, it stands out as promising to explore how these devices might be adapted as tools for data collection in large scale surveys. In India, smart phones have tripled in recent years and it is reasonable to expect wide diffusion into rural areas following the path taken by mobile phones. Smart phones through use of applications can capture data in close proximity to its

occurrence. Further, their use can facilitate data processing and management, support compliance and can result in considerable reduction in turnaround time for production of survey findings. Therefore, we propose to test the feasibility of integrating smart phone based diary approach for prospective collection of household expenditure data for understanding catastrophic health expenditures and underlying individual and contextual factors.

Public health significance: Health information systems are essential for planning, implementation and monitoring of developmental programs. Among low- and middle-income countries, India has the longest series of household consumption and health surveys - a major component of a strong health information system. While data from such surveys have proven useful, one of the major challenges is the ability to include timely, valid and rapid estimates of key development indicators. Current approaches to household survey data collection are both resource and time intensive. It requires use of large teams of specifically trained enumerators, data entry and management personnel and intensive monitoring of field activities resulting in considerable time lag between data collection and production of results. As a consequence, it leads to critical gaps in availability of up-to-date information required for an effective analysis to make public health decisions, informing policies and programs. For policymakers and program implementers, this becomes a barrier to act swiftly within a required timeframe when monitoring and planning developmental programs.

Alternatively, leveraging the recent advances in smartphone technology, data collection can be based on "self-reports" of survey respondents recruited from the general population. This participatory form of survey captures information directly from the general population, disseminates in near real-time and bypasses the need for an enumerator dependent survey data lifecycle process. Reported data can be aggregated and visualized in near real-time allowing immediate feedback to users and public health agencies. A major impediment in taking advantage of these modern approaches is lack of information on acceptance, compliance and completion rates and data validation (magnitude of its agreement with the existing approach). While multiple research initiatives focus on specific diseases and interventions, research on interventions strengthening broader health information systems has been limited. This proposal is to establish the feasibility of a participatory self-reporting platform using a smartphone based diary that will generate rapid and valid prospective household expenditure data.

If results from our pilot study provide support for feasibility, then this approach can be extended to larger surveys and cover similar information systems such as disease surveillance and routine reporting systems. From a technical point of view, this approach increases scalability with the amount of resources (time, personnel and computation) required to expand or change this approach is minimal in comparison to those needed to expand or change a paper-based household survey. System efficiency is an additional technical strength as major components such as collection, pre-processing, analysis and presentation of the results are integrated and amenable to

change without reducing the overall functionality of the system. Hence, an understanding of the feasibility of smartphone based participatory approach may therefore potentially generalize across a number of sub-components within the health information system.

2.4 If the project is location specific, basis for selection of location be highlighted:

We will focus our pilot survey in the Vellore Health Unit District (HUD), a health unit in Vellore district, Tamilnadu. The Vellore district has two health units: Vellore and Thirupattur. The Vellore HUD has a total population of 28,14,922 with 22,80,864 in rural and 7,62,902 in urban communities. It contains a total of 10 Community Health Centres (CHC), 37 Primary Health Centres (PHC), 231 Health Sub Centres (HSC) and two Medical Colleges.

The Christian Medical College, Vellore is a nationally recognized educational and research institute with a network of primary, secondary and tertiary care hospitals, and a network of community-based public health outreach catering to local communities. With a long history of community based research studies, CMC provides research infrastructural support to meet challenges centered on recruitment, participation, follow-up, training and co-ordination of field work and data gathering, processing and analysis. In the past, this research infrastructure has supported conduct of a wide range of population-based studies, including the establishment of birth cohort studies, demographic surveillance systems and health utilization surveys in these communities.

Recently, among a subset of this population, we tested the use of interactive-voice based mobile data systems to support antenatal care and immunization during pregnancy and postnatal period. Based on our request, the Indian Institute of Technology Madras (IITM)'s Rural Technology Business Incubator (RTBI-IITM) developed a mobile based voice enabled *two-way* communication system which can retrieve and deliver information to end users using voice interactions. The system captured antenatal visits, high-risk mothers, antenatal immunization that were self-reported by the pregnant women, while they received relevant pregnant information. During the postnatal period, the system provided immunization reminders and captured participant reported adverse events following immunization. Despite linguistic difficulties in understanding automated voice verbalizations, we found a higher rate of participation in utilization of this voice based self-reporting system. In addition to gaining familiarity with the socio-cultural context, sampling logistics, and operational field challenges in these communities, this experience has contributed to greater insight into underlying patterns involved with adoption of technological solutions for self-reporting of information. With the advantage of the prior field experience in these settings and infrastructural support from CMC, the proposed study will have a higher likelihood in ensuring greater access to these communities, higher rates of participation and minimal loss to follow-up, which are key factors in assessing the feasibility of this approach.

Further, CMC is leading multiple efforts to establish national surveillance networks to estimate incidence of childhood infectious diseases and to estimate its cost of illness in

different healthcare settings in India. The existing networks present potential for natural extension to expand the cover of this smart phone based platform and test scalability in surveillance or reporting systems across various settings in India.

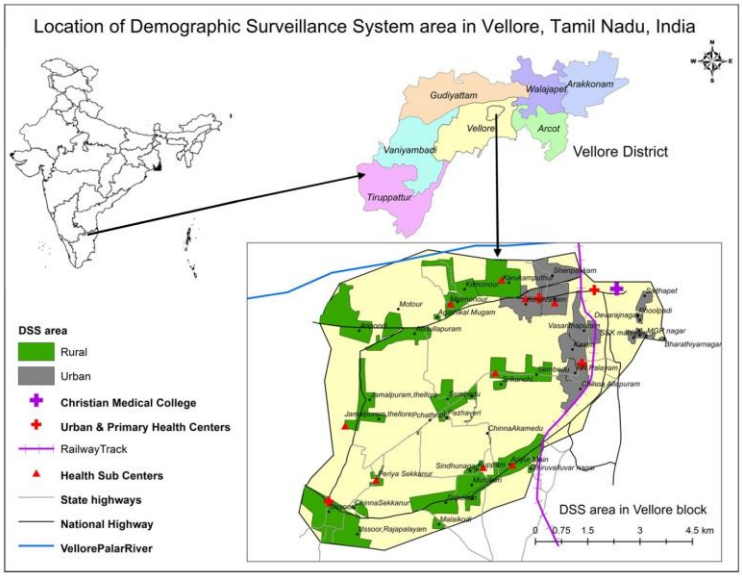
3. Work Plan:

3.1 Methodology:

Objective (1) what is the level of out-of-pocket payments for healthcare and its impact in causing catastrophic health expenditures?

Study site: Within the Vellore Health Unit District, to ensure adequate representation of rural and urban communities, the geographical regions will be stratified into urban and rural regions. Households from urban and rural regions will be selected using a two stage random sampling scheme. In the urban regions, a list of census enumeration blocks will be used as the sampling frame. In the first stage, a sample of 10 blocks will be randomly selected with probability proportional to size and subsequently 30 households will be randomly selected from each block to result in a total sample size of 300 urban households.

Figure 1



In rural areas, the first stage of selection will involve random selection of 20 villages with probability proportional to size. In the second stage, a random sample of 30 households from each village will be selected to result in a total sample size of 600 rural households.

Figure 1 shows the location of Vellore district in India and areas covered under one of the demographic surveillance sites (n=150,000) comprising both urban and rural areas in Vellore block. This provides the possibility of resulting sample blocks containing one urban and one rural area from the existing DSS sites which can then be used to inform future studies in these populations.

In selected households, a baseline survey will be conducted to document socio-demographic characteristics of households and provide background data on distribution of households' total and health-related expenditures. The baseline survey will be followed by four rounds of monthly interviews covering a quarter of a year for each household. We define the unit of analysis as households – a group of people sharing a roof and a cooking pot (census of India).

The target sample size for the survey is n=900. The sample size is calculated based on previous studies, which reported 10-20% of households' experience catastrophic health expenditures using a four month prospective diary based approach(25). Assuming a design effect of 2, and non-response rate of 10%, this sample size will estimate the proportion of households experiencing catastrophic health expenditures with a 95% confidence interval of approximately ± 3.

Study survey methods: A core team consisting of survey staff (enumerators, supervisor and data manager), social scientist and project manager will conduct the planning, training and implementation of the survey. Prior to the survey, a map representing the communities, distances and access routes will be prepared along with the type of transportation required to reach each community and the estimated time using this form of transportation. Further a physical description of each community cluster will be made including its general size, layout of community, health facilities, and other useful information required to facilitate the survey. A survey manual will be prepared comprising details of methodological and conceptual framework of the survey, sampling units, survey instrument and training materials, logistical arrangements and plans for monitoring of fieldwork. The enumerators will undergo training on the survey instruments and data collection and recording. The survey team will meet with the community leaders to enlist their help in determining the logistical information required and discuss the survey objectives and procedures before the beginning of the survey.

Once permission from local leaders is obtained, surveyors will visit the selected households, explain the objectives, study procedures, time-line and obtain consent to participate in the survey. After obtaining consent, surveyors will collect baseline information on households, including household roster, education and occupation, smartphone/technology usage and socio-economic status. The first round of the expenditure survey will be done at end of month1 (wave1) following recruitment. Data on households' total and health expenditure patterns will be obtained using a structured instrument adapted from the study of global ageing and health (SAGE-INDEPTH network)(44). Households will be revisited at the end of each month till month-4 to collect information on household expenditure patterns. All waves of measurement (month1, month2, month3 and month4) will use varying timeframe from last 7 to 30-day recall depending on the category of expenditure. All data collection will be monitored and reviewed by field supervisors for completeness and accuracy. Data from these expenditure surveys will be used to understand the overall level, distribution and composition of total and healthcare expenditures of the households.

Data analysis: Hierarchical clustering algorithms will be used to cluster households with similar patterns of expenditures. To calculate the proportion of households incurring catastrophic health expenditure, we will view healthcare expenditure as proportion of total expenditure and use different levels to threshold (10%, 15% and 25%). Further, using the WHO definition of catastrophic health expenditure, we will express health expenditure as proportion of total expenditure excluding expenditure on

basic subsistence. We will examine pattern of changes in the distribution of household expenditures over time, between month1 and month4 and assess how households displace or replace resources over expenditure categories. To identify household and contextual factors associated with probability of catastrophic health expenditure, we will use logistic regression models stratified by urban-rural populations.

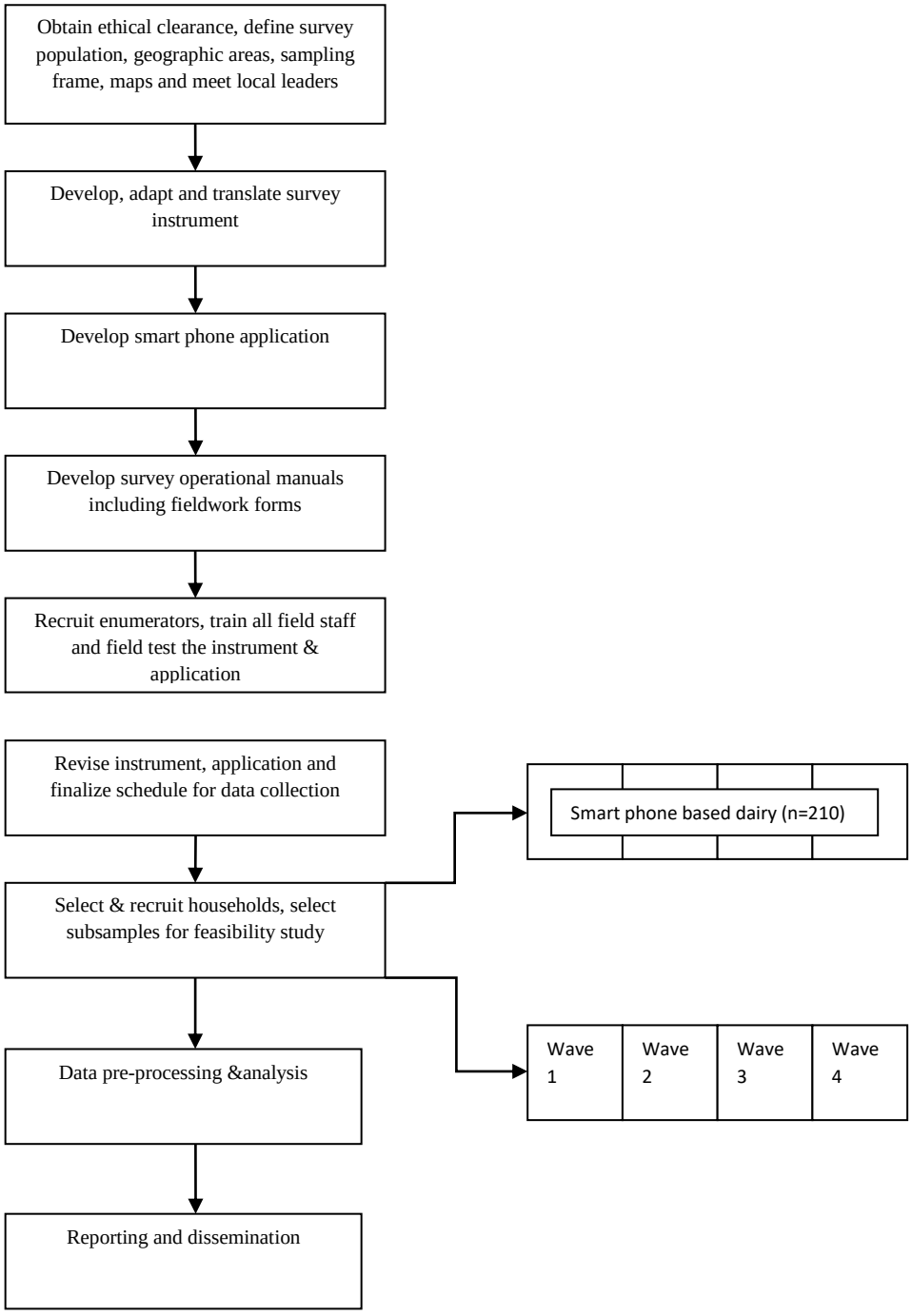


Figure 2: Flow chart of survey process

Objective (2): Is a smart phone approach feasible for measurement of catastrophic health expenditures?

To assess feasibility of using smart phone for the expenditure diary data collection, we will use a stratified random sample of 210 households (~30%) of our total sample selected in the baseline expenditure survey. Assuming a 60% compliance rate, design effect of 2 and a non-response rate of 10%, we calculated a sample size of 210 will be adequate for the estimate to be within a margin of error of 10%. The selection methodology for the feasibility study will closely track the expenditure survey sample. During the initial recruitment visit, households selected for the feasibility study will be asked to nominate one person to represent the household, who is willing to use a smart phone and be responsible for timely entries in the smart-phone based diary. The nominated respondent will attend a short training session on the use of the smart phone application, its interface, installation, structure and length of reporting and a few sessions to practice reporting of expenditure data. During this session, respondents will be asked to report expenditures either real-time or at the prompt of notifications on end of each day over the course of the next 120 days. Respondents will be reminded the importance of making regular entries as close as possible to the actual expenditure. After the completion of the training, participants will be given a smart phone for study use at the beginning of the study. While they receive the handset from the research team for the use of study purposes, the respondent will have to earn 120 credits (1 credit per day) to keep the handset upon the completion of the study. Further to increase day-to-day compliance, respondent will receive micro-incentives in the form of small payments either as pre-paid mobile talk-time or data on timely uploading of their daily records. The amount of pre-paid talk-time or data will vary between 0, 5, 10, 15, 20 and allocated randomly across households. Respondents will be contacted at the end of each week to provide feedback on the usage, identify potential problems and monitor the accessibility and efficiency with which components of smart-diaries are being used.

Design of application: The expenditure smart phone application will be designed for smart phones running under Android operating system using a customized interface for Open Data Kit (ODK). The design of the smart phone app will have two main components 1) An user-friendly interface to self report major household expenditure categories, including food, clothing, utilities, education, travel and healthcare. The interface will have pictorial representation to best symbolize the major categories, which can easily be recognized. All entries of data will include a date/timestamp, stored locally on the smartphone and transmitted over the internet to the study database daily and 2) Each day at a programmed time, an automated remainder system will be set up to send push notifications/alerts to improve compliance with daily recording of household expenditure. We will conduct both an iterative internal desk

testing and a small field testing (5-10 samples) to refine the design components of the applications.

Data analysis: Data from the app will be converted into comma separated values (csv) for further statistical analysis. We will visualize data for each participant across all days to produce an average heatmap of smart-phone diary usage. We will use completion and compliance as two indicators to measure feasibility of the smart-phone application as a survey data collection tool. Completion rates will be calculated by dividing the number of actual entries made across different categories of expenditure over the total number of categories. Compliance rates will be defined as the number of actual entries out of total number of expected entries in the study period. We will also calculate the overall feasibility as average fraction of participants completing the diary on a given day. Compliance and completion rates will be compared across groups receiving different rates of daily incentives. Further, we will estimate survey costs per completed interview under smart-phone based diary approach and survey approach. The cost refers to the global cost of personnel, transportation and incentives, and costs for training, data entry and data analysis, divided by the number of completed interviews.

Objective (3) How does expenditure data from near real-time smart phone based diaries correspond with retrospective recall of expenditure based on a traditional sample survey?

To gain a better understanding of how retrospective reports correspond to actual day-to-day reporting, we will link data from the sample of 210 households in which both smart-phone diary data and cross-sectional survey data available (through dual-methods). The traditional survey will be conducted using instruments from the SAGE-INDEPTH study based on retrospective assessment of household expenditure. Smart-phone based diaries are specifically built for the purpose of self-reporting of expenditure information in real or near real-time using smart phones. We aim to examine (1) whether retrospective reports tend to represent peak/end effects compared to daily reporting of expenditure through smartphone application, and (2) how retrospective reports compare with daily reporting in terms of overall between person variability. **We hypothesis that expenditure estimates from smart phone based diaries will be associated with greater within and between person variability and would be better correlated with baseline socio-demographic factors than cross-sectional survey data.**

Data will be analyzed in three parts to understand the relationship between retrospective reports and diary approach. In the first part, monthly expenditures from retrospective reports will be compared with summary descriptors of daily expenditures from the diary approach. The descriptors of diary expenditure such as mean, median, minimum, maximum and mean response from the last week of each month will be calculated. The descriptors of the diary approach will be compared with recalled-monthly expenditure to identify what the recall is most closely approximated.

Concordance coefficients will be calculated to assess the level of agreement between monthly expenditure and descriptors of daily diary expenditure. We will use rank-correlation methods to rank households according to the two methods. Data on expenditures will be categorized using quartiles and quartile agreement for expenditures between the two methods will be calculated. We will assess the overall expenditure and healthcare expenditure for each household by the two methods and assess individual and average household differences in expenditure estimates between the smart phone based diary data and the traditional sample survey.

In the second part, we will use data on households' socio-demographic characteristics to identify factors, which are related with differences between monthly expenditure and daily expenditure patterns from the diary approach. The expenditure patterns for the daily dairy approach include the range of expenditure (maximum-minimum), the standard deviation of the expenditure, the mean of the expenditure, the median of the expenditure and the mean of expenditure during the last week. Difference in expenditure between the two approaches will be calculated and regression methods will be used to identify factors associated with differences in expenditure patterns.

In the third part, we will analyze total variability in expenditures as components of within and between household variability and compare between the two methods. The time course of individual and aggregate expenditure trajectories will be visually examined using longitudinal plots. This will enable assessment of trends in within-household change over time and the overall between-household differences in expenditure levels. Multi-level modeling approaches will be used to determine how much variability in household expenditure is due to between-household differences against within-household change for each of the approach. Further, we will explore different models and use likelihood ratio tests to determine whether both initial level and rate of change in expenditure differ between the two approaches and dairy approach show a steeper rate of change in expenditure compared to the monthly response.

3.2 Time Schedule of activities giving milestones through BAR diagram.

Key Milestones	Pre-survey								Field testing														Post-survey					
(Months)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Survey instrument adaptation & translation																														
Survey manual & SOP development																														
IRB approval																														
Meeting with local groups																														
Development of Smartphone app																														
Procurement of equipments/consumables																														
Recruitment of field staff																														
Training / Field visits /																														
Recruitment of study participants																														
Field operations																														
Database creation / pre-processing																														
Preliminary results																														
Final results and Publication																														

3.3 Suggested Plan of action for utilization of research outcome expected from the project.

Results from this project will demonstrate whether smartphone based diary approach can capture households' expenditure patterns and the impact of health shocks, as they happen. If successful, this may be a scalable tool, which can contribute towards development of robust platforms for participatory real-time data collection to map health shocks, channeling research resources more efficiently than a traditional household survey. We plan to interact with researchers from survey organizations, present in academic conferences and use local meetings and other modes of briefing notes to reach wider audiences. Further, findings from the project will be disseminated through publications in peer-reviewed journals.

3.4 Environmental impact assessment and risk analysis. *(Maximum ½ page)*

NA

4. Expertise

4.1 Expertise available with the investigators in executing the project

Our survey research team includes investigators from the Community Health Department, Christian Medical College, Vellore which is focused on the understanding population and health demographic dynamics through collection of household survey data. The department has a strong background in design and conduct of field surveys, population based cohort studies, community engagement programs and management of demographic databases for rural, urban and tribal communities. This strong field expertise will be critical in successful implementation of the survey activities of the proposed project.

4.3 Key publications published by the Investigators pertaining to the theme of the proposal in the last 5 years

Srinivasan R, Mohan VR, Venugopal S, Kang G.Utilization of Preventive and Curative Services in Five Rural Blocks of a Southern Indian District. Indian Pediatr. 2017 Jun 4

Samuel P, Antonisamy B, Raghupathy P, Richard J, Fall CH. Socio-economic status and cardiovascular risk factors in rural and urban areas of Vellore, Tamilnadu, South India.Int J Epidemiol. 2012 Oct;41(5):1315-27.

Gopichandran V, Claudius P, Baby LS, Felinda A, Mohan VR. Household food security in urban Tamil Nadu: a survey in Vellore. Natl Med J India. 2010 Sep-Oct;23(5):278-80.

Mohan VR, Muliyil J. Mortality patterns and the effect of socioeconomic factors on mortality in rural Tamil Nadu, south India: a community-based cohort study. Trans R Soc Trop Med Hyg. 2009 Aug;103(8):801-6.

Jacob J, Joseph TK, Srinivasan R, Kompithra RZ, Simon A, Kang G.
Direct and Indirect Costs of Pediatric Gastroenteritis in Vellore, India.Indian Pediatr. 2016 Jul 8;53(7):642-4.

6. List of facilities being extended by parent institution(s) for the project implementation.

6.1 Infrastructural Facilities

Sr. No.	Infrastructural Facility	Yes/No/ Not required Full or sharing basis
1.	Workshop Facility	Yes
2.	Water & Electricity	Yes
3.	Laboratory Space/ Furniture	Not required
4.	Power Generator	Yes
5.	AC Room or AC	Yes
6.	Telecommunication including e-mail & fax	Yes
7.	Transportation	Yes
8.	Administrative/ Secretarial support	Yes
9.	Information facilities like Internet/Library	Yes
10.	Computational facilities	Yes
11.	Animal/Glass House	Not required
12.	Any other special facility being provided	Not required

6.2 Equipment available with the Institute/ Group/ Department/Other Institutes for the project:

Equipment available with PI's Department	Generic Name	Model, Make & year of purchase	Remarks including accessories available and current usage of equipment
	NA	NA	NA

7. Name and address of experts/ institution interested in the subject / outcome of the project.

Dr. Indrani Gupta
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2. Xu K, Evans DB, Carrin G, Aguilar-Rivera AM. Designing health financing systems to reduce catastrophic health expenditure. Tech Brief Policy Mak. 2005;

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