Profile: Health and Demographic Surveillance System in peri-urban areas of Karachi, Pakistan [version 1; peer review: 1 approved with reservations, 2 not approved]

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Abstract
The Aga Khan University’s Health and Demographic Surveillance System (HDSS) in peri urban areas of Karachi was set up in the year 2003 in four low socioeconomic communities and covers an area of 17.6 square kilometres. Its main purpose has been to provide a platform for research projects with the focus on maternal and child health improvement, as well as educational opportunities for trainees. The total population currently under surveillance is 249,128, for which a record of births, deaths, pregnancies and migration events is maintained by two monthly household visits. Verbal autopsies for stillbirths, deaths of children under the age of five years and adult female deaths are conducted.

For over a decade, the HDSS has been a platform for a variety of studies including, calculation of the incidence of various infectious diseases like typhoid bacteremia, pneumonia and diarrhea, evaluation of effectiveness of various treatment regimens for neonatal sepsis, assessment of the acceptance of hospitalized care, determination of the etiology of moderate to severe diarrhea, assessment of burden and etiology of neonatal sepsis and a multi-centre cohort study measuring the burden of stillbirths, neonatal and maternal deaths. We have also established a bio-repository of a well-defined maternal and newborn cohort.

Through a well-establish HDSS rooted in maternal and child health we aim to provide concrete evidence base to guide policy makers to make informed decisions at local, national and international levels.

Open Peer Review

Approval Status

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1. Daniel D. Reidpath1, Monash University Malaysia, Selangor, Malaysia

Hyi-Yenn Thoo, Monash University Malaysia, Selangor, Malaysia

2. Peter Byass1, Umeå University, Umeå, Sweden

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Any reports and responses or comments on the article can be found at the end of the article.
Keywords
Karachi, Health and Demographic Surveillance System, HDSS, maternal and child health, longitudinal studies.

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Competing interests: No competing interests were disclosed.

Grant information: Bill & Melinda Gates Foundation [OPPGH5307, OPP1033572]. Dr Imran Nisar and Dr Fyezah Jehan were supported by grant number 1 D43 TW007585-01 from the National Institute of Health's Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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How to cite this article: Muhammad Zeb MI, Naeem K, Fatima U et al. Profile: Health and Demographic Surveillance System in peri-urban areas of Karachi, Pakistan [version 1; peer review: 1 approved with reservations, 2 not approved] Gates Open Research 2018, 2:2 https://doi.org/10.12688/gatesopenres.12788.1

First published: 04 Jan 2018, 2:2 https://doi.org/10.12688/gatesopenres.12788.1
Introduction
Pakistan has a national database for registering vital events, such as births and deaths, but coverage is sub-optimal with many births and deaths going unrecorded. Undercounting of these events leads to inaccurate estimates of vital health indicators. This inaccuracy hinders setting up of priorities and allocation of scarce resources at a national level. The Health and Demographic Surveillance System (HDSS) was established in 2003 by the Department of Paediatrics and Child Health of the Aga Khan University, Karachi, Pakistan, in peri urban areas of Karachi, with the mandate to ameliorate some of these gaps. The HDSS provided a research platform for both observational and interventional studies that could influence decision-making and planning for health strategies at local, national and international levels, as well as research training opportunities for students.

At the outset, various epidemiological studies were conducted in the area on infectious diseases of children, vaccine coverage and the impact of multiple interventions. This article provides detailed information about set up of this surveillance system, data collection methods, studies that were completed, and on-going and future plans.

HDSS structure
What area does it cover?
Karachi is the largest metropolitan city, a commercial hub and a principal port of Pakistan, with an estimated population of 14.9 million including peri-urban areas (http://www.pbscensus.gov.pk). Located by the Arabian Sea, HDSS was established in four peri-urban low income communities in Korangi and Bin Qasim towns. Of the four peri-urban communities, three are contiguously located along the sea coast of Karachi; Ibrahim Hydri, Ali Akbar Shah Goth and Rehri Goth (Figure 1). The main occupation of people living in these communities is fishing. The fourth community, Bhains colony, is located at the outskirts of Karachi and the source of their livelihood is cattle rearing. In recent years Bhains colony has shown rapid urbanization.

In 2010, the area was digitally mapped using global positioning system (GPS) techniques and boundaries were constructed. KHDSS lies on the latitude 24.8508° N and longitude 67.0181° and covers an area of 17.6 square kilometres.

Surveillance structure
The Surveillance sites have been divided into 195 blocks each containing about 200–250 structures. There are a total of 42,093 structures where 43,098 households are living. A ‘structure’ is defined as a building with a single entrance and a boundary. These structures can be houses, hospitals, dispensaries, schools, shops, parks etc. Each structure has a unique number assigned to it. A ‘household’ is a group of people living together under a roof (structure) and sharing the same cooking pot. A ‘resident’ is defined as a person who stayed for at least six months or intends to stay for more than six months in the community.

Figure 1. Map showing location of the Demographic Surveillance System sites in Pakistan, Karachi and Bin Qasim town.
Until 2014, quarterly enumeration was done. After 2014, this was intensified to every two months, to be done by trained community health care workers (CHWs). CHWs are women with a secondary level of education and are mostly residents of the same communities where surveillance is taking place. At each two monthly re-enumeration, CHWs move through the area using GIS-derived maps and collect the information from households. If a household has married women of child bearing-age, any new pregnancy is documented and followed. All the information is documented on a printed form, which has a specific section for entering data about pregnancy status, any in/out-migration and newly born child to the household. If a pregnancy within a household has been identified in the previous rounds, the interviewer affirms if that woman is still pregnant or her pregnancy has ended in a live- or still-birth.

Married women surveillance
In HDSS, only married women of child bearing age (15 to 49 years) and children under the age of five years are being identified and followed. Verbal consent is taken for inclusion in HDSS and a unique identification number (ID) is assigned. For inclusion into subsequent studies/trials, written informed consent is taken as per the ERC requirement. For the purpose of HDSS, information is collected from these married women about their pregnancy status and birth outcomes. Information is also collected about in/out migration, adult female deaths and deaths of children under five years of age. Additionally, a census is conducted every five years.

Newborn surveillance
When a married woman is found to be pregnant at least four visits are made during pregnancy to closely ascertain the outcome. Upon a live birth, the newborn is assessed for the World Health Organization (WHO)’s seven danger signs and is referred to the site’s primary health centre for management and/or further referral. All newborns are followed at day 0, 3 and 10 after the birth and subsequently every two months. In case of a stillbirth, child death (under 5 years of age) or adult female death, Verbal Autopsy (VA) is conducted by a senior research assistant (with a Masters level degree in Sociology or related field). VAs are later analysed by physicians to determine the cause of death.

Primary health care
Each site has its own primary health care (PHC) centre that has been established and operated by the Aga Khan University Department of Paediatrics and Child Health. These PHCs are accessible to populations within their catchment area and provide free care to children under five years of age.

Data management
We have an integrated computerized system for entering and storing data. Core system was designed and developed in-house using MS Access (Microsoft Corporation). It consists of data entry screens, data edit and update screens, customized reports generation and data cleaning modules. The data is maintained at a central server at the Paediatrics Research Office, located about 25 kilometres from the field sites. A backup is also created.

Outputs of the HDSS
Since the completion of baseline census in 2010, we have been recording demographic information about vital events, migration patterns and various other socioeconomic factors. The demographic characteristics for the year 2016 are summarized in Table 1. The current estimated population is 249,128. Of these, 129,546 (52%) are males and 119,581 (48%) are females. Of the total population, 25% consist of females of reproductive age (between 15 to 49 years) and 16% consist of children under five years of age. The main demographic indicators have been represented in Table 2 for a period of five years. Figure 2 shows the trends of under 5 child mortality in the DSS from year 2012–2016. Under 5 mortality rates peaked in 2013 and 2016 due to measles epidemic (data not shown). Within the time period of five years, a reduction in neonatal mortality rates has been observed. (Table 2 and Figure 2).

HDSS allows for an efficient, cohesive and dynamic surveillance system. Some of the initial studies included identifying signs and symptoms in young infants requiring urgent referral and measuring the incidence of vaccine-preventable diseases such as rotavirus associated diarrhea, pneumonia, invasive pneumococcal disease, typhoid bacteremia and diseases, such as omphalitis and their contribution in causing neonatal mortality1–4.

Additional studies, added later, included, studying etiology of moderate to severe diarrhea (Global Enteric Multicenter Study or GEMS), comparison of effectiveness of different antibiotic regimens given as an outpatient therapy for management of

| Table 1. Health & Demographic Surveillance System profile (2016). |
|---------------------------------|-----------|
| **Indicators**                  | **2016**  |
| Total population, N             | 249,128   |
| Total area                      | 17.6 Sq Km|
| Total structures                | 42,093    |
| Total households                | 43,098    |
| Population density/Sq Km        | 14,134    |
| Total male population, n (%)    | 129,546 (52%) |
| Total female population, n (%)  | 119,581 (48%) |
| Total population 15–49 years (females) | 62,282 (25%) |
| Married women, n (%)            | 43,448 (17%) |
| Children <5 years, n (%)        | 40,998 (16%) |
| Annual pregnancies              | 8,264     |
| Annual live births              | 7,525     |
Table 2. Health & Demographic Surveillance indicators and trends by year.

<table>
<thead>
<tr>
<th>Indicators (rate/ratios)</th>
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<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude birth rate per 1000 population</td>
<td>29.9</td>
<td>27.3</td>
<td>26.0</td>
<td>28.7</td>
<td>25.2</td>
</tr>
<tr>
<td>Maternal mortality ratio per 100,000 live births</td>
<td>426.9</td>
<td>361.0</td>
<td>427.0</td>
<td>373.6</td>
<td>336.2</td>
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<tr>
<td>Neonatal mortality rate per 1000 live births</td>
<td>44.8</td>
<td>51.0</td>
<td>42.3</td>
<td>37.0</td>
<td>39.5</td>
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<tr>
<td>Infant mortality rate per 1000 live births</td>
<td>66.7</td>
<td>77.0</td>
<td>65.8</td>
<td>58.0</td>
<td>62.5</td>
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<tr>
<td>Under-five mortality rate per 1000 live births</td>
<td>78.5</td>
<td>89.0</td>
<td>77.2</td>
<td>70.9</td>
<td>76.7</td>
</tr>
<tr>
<td>Stillbirth rate per 1000 births</td>
<td>26.9</td>
<td>33.0</td>
<td>34.8</td>
<td>27.0</td>
<td>30.3</td>
</tr>
<tr>
<td>Abortion rate per 1000 women aged 15–49 years</td>
<td>5.0</td>
<td>5.8</td>
<td>4.0</td>
<td>6.1</td>
<td>7.0</td>
</tr>
<tr>
<td>Pregnancy rate per 1000 women aged 15–49 Years</td>
<td>186.6</td>
<td>163.2</td>
<td>157.0</td>
<td>183.4</td>
<td>185.6</td>
</tr>
<tr>
<td>General fertility rate per 1000 women aged 15–49 Years</td>
<td>119.6</td>
<td>109.2</td>
<td>104.0</td>
<td>114.9</td>
<td>100.7</td>
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<td>Child-woman ratio</td>
<td>707.0</td>
<td>683.0</td>
<td>629.0</td>
<td>608.0</td>
<td>548</td>
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<tr>
<td>In-migration per 1000 midyear population</td>
<td>54.3</td>
<td>44.2</td>
<td>33.7</td>
<td>21.1</td>
<td>25.0</td>
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<tr>
<td>Out-migration per 1000 midyear population</td>
<td>20.0</td>
<td>13.5</td>
<td>6.4</td>
<td>3.9</td>
<td>2.8</td>
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<tr>
<td>Crude net migration rate</td>
<td>34.3</td>
<td>30.8</td>
<td>27.3</td>
<td>17.1</td>
<td>22.2</td>
</tr>
</tbody>
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Figure 2. Child mortality rates from 2012–2016. U5MR, under-five mortality rate; IMR, infant mortality rate; NMR, neonatal mortality rate.

Sepsis in young infants (Simplified Antibiotic Therapy Trial or SATT) and a community-based etiology study of possible serious bacterial infections in young infants (0–59 days) (Aetiology of Neonatal infection in South Asia or ANISA)\(^{13}\).

Currently, ongoing studies include exploring coverage of routine childhood immunizations and their impact on disease transmission, e.g. impact of 10 valent pneumococcal vaccine on nasopharyngeal carriage, a randomized control trial (RCT)
(NCT02372461) for comparison of Amoxicillin and placebo in non-severe pneumonia in children 2 to 59 months old (RETAPP), and usefulness of thermal images in diagnosing pneumonia in children under five years of age. In order to understand the intergenerational effects of disease across the continuum of adult female, maternal and child health, relevant large cohort studies were added, Alliance for Maternal and Newborn Health Improvement study (AMANHI)1–15.

**Discussion**

HDSS has been proved as an important platform for carrying out various public health projects. Several studies done at HDSS have led the efforts to aid policy makers in making important decisions. One of these studies was the Young infant clinical signs study (YICSS), which led to the formulation of WHO seven sign algorithm for detection of possible serious bacterial infection (PSBI) in young infants. This algorithm was then incorporated into the Integrated Management of Childhood Illness (IMCI) and is in use to date1.

An RCT (NCT00189384) compared (1) procaine-penicillin and gentamicin, (2) ceftriaxone and (3) trimethoprim-sulfamethoxazole (TMP-SMX) regimens for the treatment of newborns, aged 0 to 59 days, with PSBI in an outpatient setting, when hospitalization is declined. TMP-SMX showed the highest failure rate and case fatalities. Procaine penicillin-gentamicin turned out to be the most cost effective route to treat these bacterial infections5.

As a follow up to this trial, a randomized control open-label equivalence trial (SATT) (NCT01027429) in young infants with clinically diagnosed severe infections (CSI), seen at PHC, was done. The trial aimed to evaluate if (1) IM gentamicin once daily (OD) and oral amoxicillin twice daily (BD) for 7 days; and (2) IM penicillin and gentamicin OD for two days followed by oral amoxicillin BD for five days are equivalent to seven days of (3) IM procaine penicillin and gentamicin (reference therapy). The primary outcome of this trial was treatment failure (death, deterioration or lack of improvement) within seven days of enrollment. Treatment failure rate were equivalent across three regimens. These findings were subsequently incorporated in the WHO guidelines for the management of young infants with CSI, and IM gentamicin OD and oral amoxicillin BD for 7 days was chosen as the treatment of choice6.

A study, Global Enteric Multicenter Study (GEMS), exploring etiology of moderate to severe diarrhea, using quantitative molecular diagnostic methods showed *Shigella* spp, *Rotavirus*, *Adenovirus* 40/41, *ST-ETEC*, *Cryptosporidium* spp, and *Campylobacter* spp are responsible for 77.8% of all diarrheal causes3.

In another study, health seeking behavior for sick young infants was studied. The acceptance rate of hospitalized care was found to be 24%. Reasons for high refusal rate included financial difficulties, elders denying permission and some based their decisions on religious and cultural beliefs. The acceptance of hospitalization was higher when the mother recognized the severity of the illness, presence of grunting, temperature <35.5°C and absence of language barrier at the local hospital. Gender was not a determining factor in decision making. This information forms learning points for interventions promoting health seeking behavior and formulation of alternative community based management plans for the betterment of child survival8,10.

An RCT aimed to compare immunization coverage by administering pictorial messages promoting vaccines to mothers versus administering general health promotion messages to the control group. An improvement of 39% in the completion of Pentavalent vaccines was seen in the intervention group, which shows that simple health awareness interventions can go a long way in raising the health status of low-income communities30.

A randomized double blinded placebo-controlled equivalence trial (MATT; NCT01533818) was conducted in primary care settings, which aimed to determine optimal management of isolated fast breathing in young infants. The primary objective of the study was to evaluate if out-patient therapy of seven days of oral amoxicillin (reference therapy) is equivalent to the placebo. The primary outcome was to see the treatment failure by evaluation of hypoxia, organ failure, anaphylaxis or hospitalization after treatment initiation. Amoxicillin treatment regimen was found to be more effective than placebo with risk difference of 3.1, p=0.04 (95% CI 0.3, 5.8)17.

A cohort study on calculating the neonatal mortality within 24 hours of birth was conducted in the rural areas of six countries, including HDSS in Pakistan. The neonatal mortality rates were higher than the published model-based estimates for these countries. Around one third of the deaths occurred during first six hours after birth and a little under half of all neonatal deaths within 24 hours. The study concluded that implementing high quality obstetric and newborn care is a priority for preventing newborn deaths early on3.

An RCT (NCT01695798) was conducted to see the immunogenicity of poliovirus vaccines in chronically malnourished infants. Infants were randomized to receive one dose of either bivalent oral poliovirus vaccine (bOPV) alone or in combination with inactivated poliovirus vaccine (IPV). The results showed that those who were given bOPV+IPV together showed to close the immunity gap more than those who were given bOPV alone19.

**Future analysis plans**

Future analysis plans include analysis of data from multi-center Aetiology of Neonatal infection in South Asia (ANISA) study1. We are currently doing analysis to determine the burden, timing and causes of stillbirths, neonatal and maternal deaths as part of the multicenter Alliance for Maternal and Newborn Health Improvement (AMANHI) study12. We are also conducting analysis to determine the burden of major maternal morbidities as part of the AMANHI study13. An additional analysis is on simplified methods to determine gestational age at birth by using a combination of physical and neurodevelopmental parameters15. Also as a part of AMANHI, we have established a bio-repository of maternal, newborn and paternal samples, collected at various time points during and after pregnancy16. To the best of our knowledge, this is the only population based bio-bank in Pakistan and one of the few in the region. Recently, we have secured funding from the Bill and Melinda Gates Foundation to
follow the AMANHI bio-bank cohort for up to three years for neurodevelopmental milestones.

Strengths and weaknesses
In our DSS, all inhabited and uninhabited structures in the area have been mapped and all women of reproductive age and children under the age of five years have been assigned a unique ID. The list is continually updated every two months. We have GIS coordinates of all structures, which allows us to look at spatial distribution of various maternal and newborn health indicators. Active surveillance of maternal and child health allows for the cohort to be a part of many multicenter studies, conducted with multiple international collaborators. Our long term presence in the area has helped us establish good rapport with the population resulting in very low refusal rates.

Currently, the HDSS covers only children under the age of five years and women of reproductive age. Older children, male adults and unmarried women are not followed. In the future, given adequate amount of funding we would like to expand our surveillance to cover these populations as well. Currently, we are using paper based forms for data collection. Increasing availability of modern technologies, like smartphones and tablets, provide an opportunity to move data collection to digital platforms.

Conclusions
All the studies conducted at our surveillance sites aim for improvement of public health policies. The information we derive, aid us in making informed decisions at local, national and international levels. These sites also play vital roles in training research personnel.

Ethical statement
Ethical approval for individual studies is obtained from Aga Khan University's Ethical review committee. Written informed consent for publication of the participants’ details was obtained from the participants/parents/guardian/relative of the participant.

Data availability
Data gathered from HDSS can be shared with other investigators with similar research interests upon receiving reasonable requests in the form of a proposal. All personal identifiers and addresses will be removed. Data sharing with other demographic surveillances provides an opportunity to learn and understand geological differences. Data sharing requests can be sent to Aga Khan University via Muhammad Imran Nisar (imran.nisar@aku.edu).

Competing interests
No competing interests were disclosed.

Grant information
Bill & Melinda Gates Foundation [OPPGH5307, OPP1033572].

Dr Imran Nisar and Dr Fyezah Jehan were supported by grant number 1 D43 TW007585-01 from the National Institute of Health’s Fogarty International Center. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Acknowledgements

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11. Zaidi AK, Baqui AH, Oza SA, et al.: Scientific rationale for study design of community-based simplified antibiotic therapy trials in newborns and young infants with clinically diagnosed severe infections or fast breathing in South


Open Peer Review

**Current Peer Review Status:** ? × ×

Reviewer Report 26 February 2018

https://doi.org/10.21956/gatesopenres.13848.r26203

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James F. Phillips
Department of Population and Family Health, Columbia University, New York, NY, USA

This narrative alerts the reader to an important demographic monitoring activity in Karachi, Pakistan. Results that are reported are of considerable value, as no comparable data exist for an urban Pakistani population.

As a report on a demographic surveillance system, the paper is seriously deficient. Internationally known citations on DSS systems are not cited. The data capture procedure is unexplained, except with a sentence noting that the procedure is paper based. Far less expensive and less complicated procedures are available that are tablet based, with core software that is accessible without cost. The rationale for the utilization of obsolete and undoubtedly costly procedures is not explained. What is the software platform for this system? Was the software developed de novo? Or is this system adapted from applications that are functioning elsewhere?

Basic design features of the HDSS system are left unexplained. The most challenging problem confronting urban longitudinal research concerns urban mobility. How is migration monitored? If migration is not monitored, how is the population at risk of events determined? What is the visitation cycle? The reader assumes that the data are stored as a relational database, but most HDSS systems define data structure by social units. This article refers to buildings as if facilities are the organizing unit for data management. This would be an unconventional procedure that merits explanation.

Beyond alerting the reader to the existence of the system and its size and output, little in this article explains how the system is designed and what urban surveillance systems elsewhere could learn from this important example.

**Is the work clearly and accurately presented and does it cite the current literature?**

No

**Is the study design appropriate and is the work technically sound?**
No

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
No source data required

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Demography

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 25 Aug 2022

Muhammad Imran Nisar

This narrative alerts the reader to an important demographic monitoring activity in Karachi, Pakistan. Results that are reported are of considerable value, as no comparable data exist for an urban Pakistani population.

Author response: Thank you for the positive feedback.

As a report on a demographic surveillance system, the paper is seriously deficient. Internationally known citations on DSS systems are not cited. The data capture procedure is unexplained, except with a sentence noting that the procedure is paper based. Far less expensive and less complicated procedures are available that are tablet based, with core software that is accessible without cost. The rationale for the utilization of obsolete and undoubtedly costly procedures is not explained. What is the software platform for this system? Was the software developed de novo? Or is this system adapted from applications that are functioning elsewhere?

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Beyond alerting the reader to the existence of the system and its size and output, little in this article explains how the system is designed and what urban surveillance systems elsewhere could learn from this important example.

**Author response:** We have now revised the article to better describe the profile of a Maternal and Child Health Surveillance System (MCHSS) and not the complete HDSS. We have elaborated on various key points such as the data collection process, database management and the structure of the MCHSS for better clarity. In 2017, the from paper-based methods were replaced by the tablet/smartphone-based collection of data. Data on migration has been added in the key findings section.

**Competing Interests:** None

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**Reviewer Report 06 February 2018**

https://doi.org/10.21956/gatesopenres.13848.r26186

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**Peter Byass**
Department of Public Health and Clinical Medicine, Umeå University, Umeå, Sweden

This is an interesting description of a surveillance operation on married women aged 15-49 and children under 5 years of age. However, such a limited surveillance operation cannot be described as a "Health and Demographic Surveillance System" - which should cover an entire defined population - and as such the title of the article is misleading. Furthermore, although this is described as a "Research Article", this is not the case - there is no research hypothesis, evaluation, or evidence-based conclusions. It is in fact a useful description of an on-going field operation, but that does not constitute a scientifically sound research article.

Some of the details are also questionable. The selection of only married women aged 15-49 will introduce severe bias in terms of some important outcomes like teenage pregnancy, abortion (natural or induced, legal or illegal). It is also not clear whether it is only the under-5 children of these married women who are included - which is another potential source of bias, since it is likely that children of unmarried women or mothers under 15 years of age would experience different risks.

**Is the work clearly and accurately presented and does it cite the current literature?**
Yes

**Is the study design appropriate and is the work technically sound?**
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
No

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Partly

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** population health; health and demographic surveillance systems

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Author Response 25 Aug 2022

**Muhammad Imran Nisar**

This is an interesting description of a surveillance operation on married women aged 15-49 and children under 5 years of age. However, such a limited surveillance operation cannot be described as a "Health and Demographic Surveillance System" - which should cover an entire defined population - and as such the title of the article is misleading. Furthermore, although this is described as a "Research Article", this is not the case - there is no research hypothesis, evaluation, or evidence-based conclusions. It is in fact a useful description of an on-going field operation, but that does not constitute a scientifically sound research article.

**Author response:** We agree with the reviewer and have revised the article to better describe the Maternal and Child Health Surveillance System (MCHSS) and not the complete HDSS. We have structured the article as a profile of the Karachi MCHSS.

Some of the details are also questionable. The selection of only married women aged 15-49 will introduce severe bias in terms of some important outcomes like teenage pregnancy, abortion (natural or induced, legal or illegal). It is also not clear whether it is only the under-5 children of these married women who are included - which is another potential source of bias, since it is likely that children of unmarried women or mothers under 15 years of age would experience different risks.

**Author response:** The reviewer has raised an important here. While it is important to assess pregnancy outcomes in unmarried mothers, in Pakistan there exists a strong cultural taboo against pregnancies in certain groups, notably unmarried women which makes it difficult to
The manuscript by Ilyas and colleagues describes an interesting and important study site in four (nearly) contiguous communities in peri-urban Karachi, Pakistan. The authors also provided examples of various research projects attributed to the success of the surveillance system's collection of data. The community of scholars working in cognate areas will be interested in, and derive benefit from, learning about their work.

Major comments

However, and the “however” is significant, the research described in the manuscript does not conform to a Health and Demographic Surveillance System (HDSS). It would be better described as a Maternal and Child Health Surveillance System (MCHSS). Frankly, this is an important innovation and should not be dismissed simply because it is not a HDSS. An HDSS follows whole of population, whereas the Agha Khan site follows “only married women of child bearing age (15 to 49 years) and children under the age of five...” (p.4) The exclusion of unmarried women is interesting, as is the under 5 cut-off.

It is noteworthy that, notwithstanding a rich and growing literature about HDSS, there is little reference made to that literature. The article by Ye et al. (2012) provides a good overview. (https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-12-741)

A further issue is the commencement date of the surveillance system. The Introduction (p.3) places the commencement in 2003, but the census was only completed in 2010 (Outputs of the HDSS p.4).

There is no statement about the response rate, whether it is constant, or declining, and mechanisms for maintaining the cohorts participation.
Additional comments

Abstract
A good, brief description of the MCHSS's profile in Karachi was given by the authors - the nature of MCHSS's establishment (year of set up, area of coverage, recorded data, purpose of the system) was clearly stated – with the exception of the confusion around the commencement date. The mentioned list of research projects following the utilisation of collected data highlights the significance of the MCHSS as a research-facilitating platform in Karachi.

Introduction
Authors could consider signposting the flow of the manuscript in a clearer way, according to the flow of the contents.

A good, general context of reasons for HDSS's set up was given, as well as the description of its geographical positioning of sites within Karachi. However, statements ended vaguely, in terms of the authors' elaboration of the respective communities. Moreover, there was a lack of information detailing reasons of the system's set up in peri-urban areas and specifically in low income communities.

The authors' explanation and description of surveillance structures could be structured better.

Inclusion and exclusion criteria of selected subjects were rather scattered throughout the article. Mothers and infants appear in one place. The enumeration of men in another. This brings back the previous point on better structuring of content. Terms on in/out migration were also lacking – did the surveillance system follow mothers and under 5's or everyone?

Outputs of the HDSS and Discussion
The authors mentioned socioeconomic factors, without elaboration. What were the factors? This comes back to the earlier point made regarding the reasons of the HDSS's set up in low income communities in areas of Karachi. What about higher income households in these peri-urban areas?

In addition, the authors could generate a summarized table of information used during surveillance.

It also seemed that the future research projects were given more focus in this article, as opposed to the key findings of the HDSS as is. While not strictly necessary for a profile paper, the results or trends found through the HDSS could be expanded further by explaining and discussing the relationship between documented socio-demographic data and collected health information of the respective communities in Karachi.

Data availability
While not a criticism of the Manuscript, rather an observation about the governance, it would be good if a more formalised description of data sharing could be referenced.

Grammatical notes
The article should be proof read and corrected prior to publication. There are a few noticeable grammatical and typographical errors.

**Is the work clearly and accurately presented and does it cite the current literature?**  
Partly

**Is the study design appropriate and is the work technically sound?**  
Partly

**Are sufficient details of methods and analysis provided to allow replication by others?**  
Partly

**If applicable, is the statistical analysis and its interpretation appropriate?**  
Yes

**Are all the source data underlying the results available to ensure full reproducibility?**  
Partly

**Are the conclusions drawn adequately supported by the results?**  
Partly

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Epidemiology, demographic surveillance, population health measurement, equity, social determinants of health

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

Author Response 25 Aug 2022

**Muhammad Imran Nisar**

The manuscript by Ilyas and colleagues describes an interesting and important study site in four (nearly) contiguous communities in peri-urban Karachi, Pakistan. The authors also provided examples of various research projects attributed to the success of the surveillance system's collection of data. The community of scholars working in cognate areas will be interested in, and derive benefit from, learning about their work.

**Author response:** We thank the reviewer for the constructive feedback.

**Major comments**

However, and the “however” is significant, the research described in the manuscript does not conform to a Health and Demographic Surveillance System (HDSS). It would be better described as a Maternal and Child Health Surveillance System (MCHSS). Frankly, this is an
important innovation and should not be dismissed simply because it is not a HDSS. An HDSS follows whole of population, whereas the Agha Khan site follows “only married women of child-bearing age (15 to 49 years) and children under the age of five...” (p.4) The exclusion of *unmarried* women is interesting, as is the under 5 cut-offs.

It is noteworthy that, notwithstanding a rich and growing literature about HDSS, there is little reference made to that literature. The article by Ye et al. (2012) provides a good overview. ([https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-12-741](https://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-12-741))

**Author response:** We agree with the reviewer and have revised the article to better describe the Maternal and Child Health Surveillance System (MCHSS) and not the complete HDSS. Unmarried women are excluded from pregnancy surveillance as it is not culturally acceptable to enquire about pregnancy status in unmarried women.

A further issue is the commencement date of the surveillance system. The *Introduction* (p.3) places the commencement in 2003, but the census was only completed in 2010 (*Outputs of the HDSS* p.4).

**Author response:** The KMCHSS was established stepwise. It was initiated in 2003 in four peri-urban areas with focus on providing a platform to various studies. In 2010 the area was geo-mapped and first census was conducted. In 2014 it was extended to one more area where the census was conducted in 2014. The most recent census was conducted in 2017.

There is no statement about the response rate, whether it is constant, or declining, and mechanisms for maintaining the cohorts participation.

**Author response:** The overall response rate for data collection at the KMCHSS sites was 94%.

### Additional comments

**Abstract**
A good, brief description of the MCHSS's profile in Karachi was given by the authors - the nature of MCHSS's establishment (year of set up, area of coverage, recorded data, purpose of the system) was clearly stated – with the exception of the confusion around the commencement date. The mentioned list of research projects following the utilization of collected data highlights the significance of the MCHSS as a research-facilitating platform in Karachi.

**Author response:** Thank you for the comment. We apologize for the confusion. The KMCHSS was established stepwise. It was initiated in 2003 in four peri-urban areas with focus on providing a platform to various studies. In 2010 the area was geo-mapped, and first census was conducted. In 2014 it was extended to one more area where the census was conducted in 2014. The most recent census was conducted in 2017.

**Introduction**
Authors could consider signposting the flow of the manuscript in a clearer way, according to the flow of the contents.
Author response: We have now revised the flow of the manuscript for better clarity.

A good, general context of reasons for HDSS's set up was given, as well as the description of its geographical positioning of sites within Karachi. However, statements ended vaguely, in terms of the authors' elaboration of the respective communities. Moreover, there was a lack of information detailing reasons of the system's set up in peri-urban areas and specifically in low-income communities.

Author response: We have revised the text to describe the communities included in the MCHSS. In Karachi, urban dwellers mostly reside in settlements in peri-urban areas with the highest population density. These peri-urban areas experience a high maternal and childhood mortality. Thus, the MCHSS was set up in these areas.

The authors' explanation and description of surveillance structures could be structured better.

Author response: Thank you for the comment. We have now added a detailed description of the MCHSS structure.

Inclusion and exclusion criteria of selected subjects were rather scattered throughout the article. Mothers and infants appear in one place. The enumeration of men in another. This brings back the previous point on better structuring of content. Terms on in/out migration were also lacking – did the surveillance system follow mothers and under 5's or everyone?

Author response: We apologize again for the confusion. The target population for the MCHSS were only women and children. We have added details on migration under the key findings section.

Outputs of the HDSS and Discussion
The authors mentioned socioeconomic factors, without elaboration. What were the factors? This comes back to the earlier point made regarding the reasons of the HDSS's set up in low-income communities in areas of Karachi. What about higher income households in these peri-urban areas?

Author response: These MCHSS was mostly set-up in low-income communities since these populations report the highest maternal and child morbidity and mortality rates. We could not explore factors such as the income, and education of the households. However, food security was assessed.

In addition, the authors could generate a summarized table of information used during surveillance.

Author response: We have now added a table (Table 1) describing the main demographic characteristics of the MCHSS.

It also seemed that the future research projects were given more focus in this article, as
opposed to the key findings of the HDSS as is. While not strictly necessary for a profile paper, the results or trends found through the HDSS could be expanded further by explaining and discussing the relationship between documented socio-demographic data and collected health information of the respective communities in Karachi.

**Author response:** Thank you. We have now elaborated on the various trends seen among the women and children in the MCHSS.

**Data availability**
While not a criticism of the Manuscript, rather an observation about the governance, it would be good if a more formalised description of data sharing could be referenced.

**Author response:** Although the data collected by the MCHSS is not open source. De-identified data can be shared with other investigators upon request.

**Grammatical notes**
The article should be proofread and corrected prior to publication. There are a few noticeable grammatical and typographical errors.

**Author response:** We have proofread the manuscript to remove any grammatical and typographical errors

**Competing Interests:** None