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# **A Case for Early Education Toward Sustainable Antibiotic Stewardship**

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## **Abstract**

Antimicrobial resistance (AMR) is a global One Health threat jeopardizing healthcare globally, with projections of more than 10 million lives prematurely lost per year by 2050. Several factors underlay this dire predicament, including a poorly educated populace and patients regarding best practices for antibiotic stewardship. Specifically, children and parents have inadequate antibiotic knowledge for basic usage but demanded accessible education. Furthermore, antibiotic stewardship regarding antibiotic disposal and the environmental effect of AMR is highly neglected worldwide but critical to address to prevent harm to human and animal health. Previously, antibiotic stewardship regarding antibiotic disposal was largely ineffective with a typically top-to-bottom approach, which requires a bottom-to-top approach to increase public awareness and support.

California should incorporate antibiotic stewardship into the K-12 education system. Attention to educational initiatives is important because children account for a large proportion of patients prescribed antibiotics, and nearly one in two antibiotics are overprescribed. Childhood educational intervention in Europe was shown to drastically cut antibiotic overuse. Therefore, more education on antibiotic stewardship is necessary to protect the future generation. Overall, to reach the National Action Plan, California must lead to address Objective 2 on conducting public education on antibiotic stewardship. Our research suggests that similar progress could be made in California and America with similar childhood educational interventions.

## **Keywords**

Antibiotic resistance  
Antibiotic stewardship  
Education  
Europe  
Healthcare  
Pandemic  
Pharmaceuticals  
Public Health  
K-12 system

## **Introduction**

Antimicrobial resistance (AMR) is a One Health epidemic jeopardizing global health, food security, and development (Jimah, Fenny, & Ogunseitan, 2020; World Health Organization, 2019). By definition, a One Health issue is one that crosses all geographic and national boundaries to affect humans, animals, and the environment (Jimah et al., 2020). It is projected to take 10 million lives and cost 100 trillion dollars by 2050 to both become the leading cause of death and wreak a global financial crisis as catastrophic as the 2008-2009 crisis, respectively (O'Neill, 2016; World Health Organization, 2019). As a result, COVID-19 may not be the only pandemic in the 21st century (Devlin, 2020).

Antimicrobial resistance has multiple causes, including inadequate public knowledge and patient pressure for an antibiotic prescription, which influences physicians to overprescribe antibiotics (Kohut et al., 2020; Ray et al., 2019). As of 2019, 43% of antibiotics are prescribed inappropriately or unnecessarily, which accounts for 30% to 50% of all AMR cases (Ray et al., 2019; Ventola, 2015). As a result, AMR is a major threat to America. Currently, antibiotic stewardship on the correct disposal of antibiotics is highly neglected and important as a highly significant cause of harm for land and aquatic animals and humans alike (Anwar, Iqbal, & Saleem, 2020). Specifically, antibiotic stewardship is defined as “the effort to measure and improve how antibiotics are prescribed by clinicians and used by patients” (Centers for Disease Control and Prevention, 2019). Currently, antibiotic stewardship experts in the medical community are inaccessible (Pulcini & Gyssens, 2013). Most are only available upon request for patients with serious infections (Pulcini & Gyssens, 2013). However, antibiotic stewardship is critical for the simplest infections. For example, common diseases like staphylococcus (staph) are difficult to treat. Staph has over 1,000 strains with over 150 antibiotics available to treat it (Jaramillo & Wuest, 2021; Li & Webster, 2018; e-Bug, n.d.). The World Health Organization estimates that it takes \$10 to 30 billion to produce and introduce 10 to 15 new antibiotics (Gunn, 2020; Renwick & Mossialos, 2018). Many large pharmaceutical companies have abandoned this field of work because of the low-profit margin (Outtersson & Boucher, 2019; Plackett, 2020 World Health Organization ” 2020;). Therefore, prudent and responsible use of existing antibiotics is urgent as one of the primary solutions, and we all have to do our part (Federal Task Force on Combating Antibiotic-Resistant Bacteria, 2020).

## **Fundamental Knowledge of Antibiotics**

Another study (2019) conducted on the American public stated that “nearly half of adults (45%) say they have personally not taken their antibiotics as prescribed by a doctor – one of the leading causes of AMR” (Muñana et al., 2019). According to Pew Research, only 42% of those in high school or less understand that antibiotics are used solely for bacterial, not viral infections (Funk & Goo, 2015). In addition, a survey with 215 respondents discovered that “over 40% of respondents indicated that antibiotics were the best choice to treat a fever or a runny nose and sore throat,” despite it being likely the worst option due to it likely being viral (Carter et al., 2016). According to a 2019 study, individuals with “high school education or below were more likely to believe antibiotics kill viruses (43.1% vs. 20.9%, respectively;  $p < 0.01$ ) and that antibiotics work on most coughs and colds (31.4% vs. 16.2%, respectively;  $p = 0.01$ )” (Seipel et al., 2019). According to a recent study, 47.1% of individuals “stop taking antibiotics when they start feeling better” (Gualano et al., 2014).

## **Patient Pressure on Healthcare Providers**

A major cause is patient pressure for antibiotics that must be addressed through education. There is an increasingly participatory role of patients in an antibiotic prescription,



so patients need to be educated to protect themselves and their dependents (Pulcini & Gyssens, 2013). Specifically, physicians account that it takes “less time to prescribe an antibiotic than to provide a lengthy explanation to a patient as to why an antibiotic is not needed” (Zetts et al., 2018). Overall, studies show a general consensus among physicians feeling “that patients and their families expect tangible actions to address their illnesses or concerns” (Zetts et al., 2018). In fact, there is a “culture of expectation” (Zetts et al., 2018). The public has become increasingly active in communicating with healthcare providers to determine correct antibiotic prescriptions, especially parents of young children (Pulcini & Gyssens, 2013). Perceived patient demand drives physicians to inappropriately or incorrectly prescribe antibiotics (Kohut et al., 2020). Perceived patient expectations and pressure for antibiotics made physicians 31.7% likelier to inappropriately or incorrectly prescribe them (Mangione-Smith et al., 2006). Specifically, a study by Mangione-Smith et al. (2011) found that physicians detected patient pressure for antibiotics in 34% of visits (King, Fleming-Dutra, & Hicks, 2018). When physicians regarded antibiotics as unnecessary, patients were “24.0% [likelier to] question the treatment plan” (Mangione-Smith et al., 2006). Another study found that physicians were 20.2% likelier to prescribe antibiotics with perceived patient pressure for treating the cold (King, Fleming-Dutra, & Hicks, 2018). Some confessed that overprescribing antibiotics could prevent patients from switching health providers (Zetts et al., 2018). Prescribers are tasked with offering optimal antibiotic therapy to patients while preserving their efficacy to prevent AMR. Patient pressures and patient expectations for antibiotics are significant issues that must be addressed through education.

Children are a target of a large proportion of antibiotic overprescribing in the United States (Zetts et al., 2018). Specifically, “patients age  $\leq 19$  years accounted for ~34.8 million antibiotic prescriptions in [outpatient settings] from 2010 to 2011” (Zetts et al., 2018). Furthermore, in 2015, five in six antibiotic prescriptions were prescribed in the outpatient setting, including physician’s offices (King, Fleming-Dutra, & Hicks, 2018). Doctors mainly have a need to protect themselves from malpractice, patients switching to other providers, and decreased patient satisfaction scores (Zetts et al., 2018). In addition, “children are especially vulnerable to multidrug-resistant infections because of the lack of pediatric pharmacokinetic and safety data for new antibiotics, which contributes to fewer broad-spectrum antibiotics being approved for pediatric use” (Zetts et al., 2018). Expanding outpatient stewardship efforts can positively impact patient health (Zetts et al., 2018). Namely, the most common cause of adverse drug events–related emergency department (ED) visits in children are antibiotics (Zetts et al., 2018). In the U.S., there are 835 antibiotic prescriptions per 1000 persons in 2014, which is incredibly high compared to other countries like Sweden, with 328 antibiotic prescriptions per 1000 persons in 2014 (Zetts et al., 2018). As a result, children are at risk of antibiotic over-prescription.

### **Need for Sustainable Antibiotic Disposal Policies and Practices**

Antibiotic stewardship regarding the proper waste disposal of antibiotics must be addressed more to the public. Currently, it is a potential driver of AMR as a significantly neglected issue harming humans and animals (Anwar, Iqbal, & Saleem, 2020). Between 2015 and 2030, antibiotic consumption is projected to “increase worldwide by 200%” (Sriram et al., 2021). Specifically, the “inappropriate disposal ends up in landfills, water supplies and drains that lead to contamination of the environment and a wide range of toxicities to humans, animals, and marine life” (Anwar, Iqbal, & Saleem, 2020). When “not degraded or eliminated during wastewater treatment,” these antibiotics “reach surface water or are passed into the aquatic environment” (Anwar, Iqbal, & Saleem, 2020). These seemingly negligible concentrations of antibiotics are actually posing extreme health risks through the antibiotic-resistant genes becoming greater and more virulent via horizontal gene transfer (Anwar,

Iqbal, & Saleem, 2020). Recently, antibiotic use and consumption have increased over the past years, causing increased rates of inappropriate antibiotic disposal (Anwar, Iqbal, & Saleem, 2020). In addition, there is a major issue with the increased usage of high-end and last-resort antibiotics globally (Anwar, Iqbal, & Saleem, 2020). Currently, the trend of failed antibiotic therapy being to use more antibiotics has created a high risk of AMR (Anwar, Iqbal, & Saleem, 2020). As a result, the increased usage lends an increased rate of improper antibiotic disposal in the environment that must be urgently addressed in the public health campaigns (Anwar, Iqbal, & Saleem, 2020).

However, the previous public health campaigns have been ineffective. This topic of inappropriate waste disposal is highly neglected, specifically among policymakers and healthcare professionals, which means that the public must be educated on this critical issue (Anwar, Iqbal, & Saleem, 2020). An organization successfully addressing inappropriate waste disposal is the Minnesota Department of Health through offering antibiotic stewardship kits and resources like fact sheets on proper antibiotic disposal and the environmental effects (Minnesota Department of Health, n.d.). Examples include the “Take it to the Box Toolkit” with information on medication drop-off programs within the community (Minnesota Department of Health, n.d.). As a result, California should create a more sustainable environment by promoting correct antibiotic disposal through similar measures, specifically at the k-12 level. In the past, both individual and collective programs with a top-to-bottom approach in informing policymaker and healthcare providers have been ineffective, which requires a grassroots approach targeting public education so that citizens can learn about this behavioral issue to create societal change, as a comprehensive yet customized approach (Anwar, Iqbal, & Saleem, 2020). By 2030, AMR is projected to bring 200 million individuals into extreme poverty (World Health Organization, 2019). AMR is evolving instantaneously, exacerbated by critically neglected environmental dangers from incorrect waste disposal (Anwar, Iqbal, & Saleem, 2020). As a result, individuals with or without access to health are at risk of AMR. With the current time and resource constraints, taking the critical step to address proper antibiotic disposal in the state k-12 curriculum, in addition to correct antibiotic use, is essential to advance antibiotic stewardship efforts worldwide as a necessary catalyst. Through this, society can protect environmental sustainability and support the health of minority individuals that are frequently affected by unsustainable environmental practices.

### **Implications of COVID-19 Pandemic on Antimicrobial Resistance**

The COVID-19 pandemic has set a precedent in revealing the deadly impacts of structural racism and systemic health inequalities on racial and ethnic minorities (Nadimpalli et al., 2021). Specifically, Black and Hispanic/Latinx populations have been disproportionately affected: they comprise less than a third of the national population but accounted for about half of all cases and 37% of all deaths (Nadimpalli et al., 2021). Racial and ethnic minorities have disproportionately high rates of comorbidities and living in crowded areas, which increases the risk of the emergence and transmission of AMR (Nadimpalli et al., 2021). As a result, Americans must contend with the structural racism and systemic health inequalities, especially in minority populations, when addressing the need for education regarding AMR, which is widely regarded as the next global pandemic (Nadimpalli et al., 2021). With higher rates of poverty, it is critical to support the education of minority populations because AMR will disproportionately affect the poor (Nadimpalli et al., 2021).

There is a further concern with racial and ethnic minorities being disproportionately impacted by low-income, which stimulates the allure of easy antibiotic access with inadequate regulations in lower and middle-income countries creates a reliance on cheaper nonprescription (Haque, 2017). However, the cost of AMR is deadly. Currently, the annual toll of AMR in the U.S. includes 2.8 million illnesses, 35,000 deaths, and economic costs in

the range of \$6000–\$30,000 per person, totaling \$20 billion to cripple low-income individuals (Center for Disease Control and Prevention, 2020a; Carter, 2016). Specifically, while African American, Latino, and Asian individuals “may receive fewer antibiotic prescriptions over their lifetimes than do” Caucasian individuals, they may be likelier to consume non-prescription antibiotics (Nadimpalli et al., 2021). A cross-study on 35 community surveys across five continents showed that nonprescription use occurred globally, which likely impacts the culture regarding antibiotics of immigrants in which America is created by immigration (Morgan et al., 2011). Nonprescription accounted for “19–100% of antimicrobial use outside of northern Europe and North America,” which should be considered with California’s population comprising of 64% racial and ethnic minorities and 27% immigrants (more than double any other state) (Haque, 2017; Public Policy Institute of California, 2021). Regarding this, race or ethnicity is just one factor that might cause disparities in AMR, in which other factors include low income, undocumented status, lack of insured, or residing in crowded urban areas, regardless of race or ethnicity, that may hinder access to healthcare and increase nonprescription (Nadimpalli et al., 2021). Society has an obligation to prevent “racial and ethnic minorities and economically disadvantaged people” from being disproportionately burdened by AMR (Nadimpalli et al., 2021). As a result, it is necessary to promote a holistic education outside of healthcare alone to prioritize public health among minority individuals, immigrants, and economically disadvantaged people, among others, because of nonprescription.

### **The Importance of Targeting the K-12 Education System**

There is a high need to strengthen the education system regarding health education and infection prevention with the pervasive use of antibiotics with the high over-prescription rates, paired with the COVID-19 pandemic that creates a scenario of potential antibiotic misuse for it or its secondary infections (Clancy et al., 2020). As a result, there must be interventions to target the k-12 system because it is critical to ensuring adequate antibiotic stewardship outside of the healthcare setting to protect low-income and racial minorities, among other people, from getting AMR through nonprescription. Specifically, O’Neil’s “Tackling Drug-Resistant Infections Globally: Final Report and Recommendations” (2016), a cornerstone AMR report, has identified children and teenagers as the main focus demographic of public awareness campaigns of drug resistance to prevent them from being the brunt of AMR as the age group most susceptibility to infections (Casadevall & Pirofski, 2018). Currently, the federal government’s “National Action Plan for Combating Antibiotic-Resistant Bacteria, 2020 – 2025” emphasizes Objective 2 to “engage the public and other stakeholders to develop, expand, and increase national and State education . . . focused on using antibiotics responsibly, stopping the spread of AMR, and preventing infections and life-threatening conditions like sepsis” (Federal Task Force on Combating Antibiotic-Resistant Bacteria, 2020). Therefore, California must emphasize antibiotic stewardship education to align with the national standards to support efforts to protect vulnerable populations like minorities, the uninsured, and the economically disadvantaged to prevent AMR from being the next pandemic of inequality (Devlin, 2020).

According to Pulcini & Gyssens (2013), antibiotic stewardship habits must develop as young as possible to foster positive habits into adulthood. In addition, children get prescribed antibiotics more than any other drug (Lovegrove et al., 2018). However, one in two antibiotics is inappropriately or unnecessarily prescribed (Spivak et al., 2018). As a result, the community-level educational focus must include the k-12 education to educate students and their parents, in which children account for a large proportion of antibiotic prescribing (Zetts et al., 2018). Furthermore, parents wanted health education regarding AMR for health

promotion (Bosley et al., 2018). Overall, there is a high need and demand for education to the k-12 demographic to effectively protect children from antibiotic resistance.

California must learn from states like Michigan, Oregon, and Minnesota in creating antibiotic stewardship material for the k-12 system (Michigan Antibiotic Resistance Reduction Coalition, n.d.; Minnesota Department of Health, n.d.). Specifically, Michigan has the Michigan Antibiotic Resistance Reduction Coalition (MARR) successfully targets the k-12 system through its wide reach across over 30 additional states and many countries (Centers for Disease Control and Prevention, n.d.; Michigan Antibiotic Resistance Reduction Coalition, n.d.). In addition, the Minnesota Department of Health has created comprehensive sources to promote antibiotic stewardship resources at the k-12 system regarding the One Health aspect (Minnesota Department of Health, n.d.). Lastly, the Oregon Alliance Working for Antibiotic Resistance Education (AWARE) offers specific modules on incorporating antibiotic stewardship at the high school, middle, and elementary school levels (Oregon.gov., n.d.). Currently, the AWARE programs are also at various states like California, Texas, and Arizona, but these states are not incorporating education on antibiotic stewardship at the k-12 level (Center for Disease Control and Prevention, 2020b). As a result, California must follow these states in addressing antibiotic resistance at the k-12 level.

### **Europe: Example of Successful Public Education on Antibiotics**

Currently, Europe is leading public education on antibiotic stewardship. Many European nations have integrated antibiotic stewardship into the elementary, middle, and high school levels via the e-Bug game (e-Bug, n.d.b). Specifically, the e-Bug curriculum is led by Gloucester's Health Protection Agency Primary Care Unit with ten associate partner countries "(Belgium, Czech Republic, Denmark, France, England, Greece, Italy, Poland, Portugal, and Spain) and eight collaborating partner countries (Croatia, Finland, Hungary, Ireland, Latvia, Lithuania, Slovakia, and Slovenia) as a project covering 62% (334 million) of the European population (Lecky et al., 2010). Other major initiatives include Do Bugs Need Drugs? and Microbes in question mobile children's health education campaign (Pulcini & Gyssens, 2013). Specifically, the "Do Bugs Need Drugs?" is a community and professional education program designed to address AMR by decreasing the inappropriate use of antibiotics" (Carson & Patrick, 2015). They developed resources "for physicians, pharmacists, nurses and the public, including children, their parents and caregivers, teachers, employers and workers, and long-term care facilities" (Carson & Patrick, 2015). It began "as a small six-month pilot in 1997 in Grande Prairie, Alberta, the program expanded to Edmonton in 2000 and to all of Alberta and to British Columbia in 2005" (Carson & Patrick, 2015). Results show that, in 1998, "27% of respondents to a public survey were able to correctly define AMR," which spiked to 77% in British Columbia by 2014 (Carson & Patrick, 2015). In essence, the United Kingdom reveals the effectiveness of educational interventions at the k-12 level.

### **Conclusion**

Antimicrobial Resistance is expected to be the leading cause of death by 2050. Childhood educational intervention in Europe has been shown to drastically reduce antibiotic overuse (Carson & Patrick, 2015). We make the case here that similar strategies could be effective in California and other states in the United States.



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## Correlation between student complaints and meteorological data

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## **ABSTRACT**

### **Purpose**

This study analyzed weather conditions due to which students are likely to get sick or suffer injuries by examining the correlation between student visits to the treatment room and weather data. The aim is to ensure that students can lead a comfortable school life. Thus, it is necessary to consider the measures that teachers need to take.

### **Methods**

We examined the correlation between the number of medical and surgical complaints by symptom in the treatment room visit record of a junior high and high school in 2019 and weather data. The main medical complaints were headache, abdominal pain, dullness, sickness, discomfort, nausea, vomiting, diarrhea, constipation, sore throat, nasal discharge, cough, anemia, and dizziness, while the main surgical ones were abrasion, sprain, and jammed finger.

For the meteorological data, the data published by the Japan Meteorological Agency was used. The items were temperature, sea level pressure, precipitation, humidity, and average cloud cover.

Correlation analysis and an uncorrelated test were conducted ( $p < 0.05$ ). Long vacation periods and school event days were excluded from the analysis.

### **Results**

The main complaints correlated with temperature were headache, abdominal pain, dizziness, constipation ( $p < 0.001$ ), discomfort, anemia, sprain, and jammed finger ( $p < 0.05$ ).

The main complaints correlated with humidity were headache and discomfort ( $p < 0.05$ ). No correlation was found between the other complaints and weather conditions.

### **Conclusions**

In adults, headaches are associated with atmospheric pressure; however, in junior high and high school students, it was associated with temperature and humidity—many students complained of poor physical condition on hot days. Teachers need to prepare the environment of classrooms and facilities accordingly, especially in the summer.

In recent years, the number of people experiencing meteoropathy has increased. In this study, the amount of precipitation and cloud cover were not directly related to student visits to the treatment room, but it is considered that there are individual differences in weather conditions that are likely to lead to poor physical conditions. Therefore, more attention should be paid to students whose illness is likely to be related to the weather, such as by keeping records.

It was also found that there were many visits for surgical complaints on hot days. When exercising on a hot day, teachers are required to instruct students to take more thorough measures to prevent injuries, such as taking frequent breaks and stretching. In addition, we believe that the number of injured and unwell students will decrease if the temperature is considered while scheduling school events, such as sports festivals and school festivals.

### **KEYWORDS:**

student complaints, meteorological condition, meteoropathy, temperature

# Effectiveness of public health interventions on improving prescription redemptions and medication adherence among Type 2 Diabetes mellitus patients: Systematic Review and meta-analysis of Randomized Controlled Trials

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## *Abstract*

**Background:** Despite an inadequate filling of prescriptions among chronic care patients has been a problem, little is known about the intervention effect on it.

**Objective:** The aim of this systematic review and meta-analysis (SRMA) was to investigate the effectiveness of various public health interventions on primary and secondary medication adherence among T2DM patients.

**Methods:** Searching was done from the major databases; Cochrane Library, Medline/PubMed, EBSCOhost, and SCOPUS. Hand search was made to find grey literatures. Articles focused on interventions to enhance primary and secondary medication among type 2 diabetes mellitus patients were included. After screening and checking eligibility, the methodological quality was assessed. Secondary medication adherence was synthesized descriptively due to measurement and definition variations across studies. Finally, meta-analysis was made using the fixed effects model for primary medication adherence.

**Results:** 3,992 studies were screened for both primary and secondary medication adherences. Among these, 24 studies were included in the analysis for primary (5) and secondary (19) medication adherences. Pooled relative medication redemption difference was RD=8% (95% CI: 6-11%) among the intervention groups. Age, intervention, provider setting, and IDF region were determinant factors of primary medication adherence. About two-thirds of the studies revealed that interventions were effective in improving secondary medication adherence.

**Conclusion:** Both primary and secondary medications were enhanced by a variety of public health interventions for patients worldwide. However, there is a scarcity of studies on primary medication adherence globally, and in resource-limited settings for type of adherences.

**Key words-** T2DM, medication adherence, intervention, meta-analysis, RCT

## I.

### INTRODUCTION

Medication adherence has not been the only interest of the patient to purchase or take the prescribed medications, but numerous factors have been affecting it among chronic and comprehensive care patients [1,2]. Medication cost, patient-physician communication, disease, medication and patient-related characters, and health care system are all affect both primary and secondary medication adherences among chronic ill patients including type 2 diabetes mellitus (T2DM) patients [3–6]. On the other hand, diabetes pandemically has been affecting around half a billion (463 million) people across the globe. T2DM constitutes 90-95% of all kinds of diabetes. If this pandemic is left uncontrolled, this number is expected to reach 0.7 billion in 2045 [7].

When patients are well adhered to, both their medications, increase the probability of prognosis and quality of life [8–10], lower hospitalization rate [11,12], balance blood glucose level [13,14], reduce both direct and indirect healthcare costs [15–18], diabetes related morbidities and mortality [19,20] among patients. However, the issue of primary medication adherence (PMA) has been a shallowly explored theme in healthcare and did not receive the required attention until the recent years [2,21,22]. Additionally, vast differences has been existing in the definition and measurement of secondary medication adherence among diabetic patients across the globe [23]. One of the recent SRMA on PMA reported that antidiabetic medication redemption was the lowest among other chronic diseases nearly 10% [24].

Nevertheless, through the active involvement of society, public health interventions are essential for promoting health, preventing disease, and prolonging life of the population. These interventions involve various approaches and require well-planned, organized, and integrated efforts of society alongside with healthcare professionals to achieve goals and targets [25,26].

Therefore, we aimed to investigate the overall effectiveness of public health interventions on improving redemption and medication adherence among T2DM patients.

### II. METHODS

Preferred reporting Items for systematic review and Meta-analysis (PRISMA) was used [27].

#### *A. Eligibility criteria*

##### *Inclusion and exclusion criteria*

The study was carried out based on the framework of PICOS (Population, Intervention, Control, Outcome, and Study design) for achieving easy, clear and vigorous stages [28] to achieve the objectives among study participants. (TABLE I) below

##### *B. Search strategy, data sources, extraction, bias assessment, and synthesis*

Cochrane Library, MEDLINE (EBSCOhost), MEDLINE/PubMed, and SCOPUS databases were used to quest for relevant articles. STATA 14 version was used to analyze the data. Secondary adherence was analyzed manually. Risk of bias was assessed using JBI tool. Pooled relative redemption difference was calculated for the effectiveness of public health intervention on PMA among T2DM patients (dichotomous data) along with a 95% confidence interval.

### III. RESULTS}

A total of 3,992 studies were found from databases and other sources. After removal of the duplicates, 2,790 were screened for eligibility. After thorough screening, 158 full texts were found eligible for further inclusion. After checking for inclusion, 24 studies met the criteria. Among twenty-four, twenty (1 primary and 19 for secondary adherence) studies were included in the qualitative synthesis and 4 PMA in the meta-analysis. (Figure 1)

Three studies from USA [29–31], and one each from Denmark [32] and Hungary [33]. All of them evaluated the impact or effectiveness of their respective public health interventions on PMA. Studies are only available

from Europe [32,33] and North American and Caribbean [29–31] IDF regions, and high-income countries as well.

#### *Overall effect size of public health interventions on Primary Medication Adherence*

The pooled effectiveness of public health interventions on PMA was significant with relative redemption of prescription among IG than control group with RD=8% (95% CI: 6-11%) with  $I^2=93.9%$ ,  $p<0.001$  with the fixed effects assumption (Figure 2). This effect shows a considerable variation across the studies. Thus, after considering the variation across the studies by applying random effects assumption, the pooled effectiveness was RD=7% (95% CI: -5-18%) with  $I^2=93.9%$ ,  $p<0.001$ . However, following a small number of studies, we ignored the heterogeneity. Thus, with the aim of improving a clinical relevance among patients, we continued our interpretation with the fixed effects assumption. **(Figure 2) below**

#### *Subgroup analysis*

Subgroup analysis was conducted using intervention type, provider, period, IDF region, WB economic classification, age group, adherence measurement (patient/prescription), continent, and study settings. However, all studies were from a single category of WB.

Intervention setting period, IDF region, and service providers come as potential contributors of heterogeneity and showed a significant effect on the outcome variables. (TABLE II) below.

#### **A. Types of public health intervention**

Multiple types of public health interventions were delivered to patients with various approaches. Interventions were provided mainly in three categories. Behavioral counselling includes direct face to face and internet supported, educational information aided materials like pictorial, simulation, leaflets and thirdly mobile phone services such as phone call, sending the reminder via SMS were mentioned.

#### *Sensitivity analysis and publication bias*

One by one omission of each study has no significant influence on the pooled outcome. However, O'Connor and colleagues' study has a marginally higher value than others on the overall effect size.

Statistically findings showed no existence of publication bias. Harbord's test with Galbraith plot fitted the regression [34] line that there is no publication bias, with the estimated intercept is 1.664 and standard error of 1.397,  $p=0.66$ . A unit increase of 1.664 log relative ratio for each unit increase will increase in the standard error of the log relative ratio. Thus, we could not decide that the publication bias was assessed since there were small numbers of included trials to accurately evaluate a funnel plot or more advanced regression-based calculations [35].

#### **B. Secondary medication adherence**

The medication adherence definitions and measurements used by the studies were not consistent. This was a hurdle to carry out the quantitative (meta-analysis) on the effectiveness of public health interventions on secondary medication adherence. About 73.7% of studies reported that the interventions were effective in enhancing secondary medication adherence among T2DM patients. This is quite in line with the previous finding [36]. Additionally, it strengthens the conclusion that multicomponent interventions provided to enhance secondary medication adherence were found be effective [23].

## **IV. CONCLUSION**

Overall effect size claimed that public health interventions for T2DM patients were found effective in enhancing prescription redemption. In a qualitative synthesis, behavioral changing, educational materials provided, and electronic or health information technology guided intervention were effective. Despite the inconsistency of measurements and the variety of interventions existing among studies for evaluating secondary medication adherence, by considering cost-effectiveness and suitability of the intervention type, it is better to scale up interventions to resource limited settings. Thus, we suggest pragmatic, vigorous, and clear randomized trials should be done to assess the effect of PMA among T2DM patients regardless of geopolitical and economic circumstances.

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TABLE I

ELIGIBILITY CRITERIA		Inclusion criteria	Exclusion criteria
Framework			
Population		Adult patients (greater than 18 years and above), all ethnicity, both sex, who had been on antidiabetic drugs at the baseline	T1DM, gestational DM and other forms of diabetes
Intervention		Any type of public health intervention (behavioral change through information education and communication, provision of medical supplies and drugs, upgrading or capacity building of skill and competencies, human resource acquisition, short message services, applications, health promotion, psychological care) either locally adapted approach or HIT guided	Those interventions deviate from the listed ones
Comparator		T2DM patients on placebo, usual/standard care or no care at all	If there is reported information contamination or intervention that equates with intervention groups
Outcome		Redemption, refilling or adherence to antidiabetic and related medication prescriptions	Other biomarker outcomes as primary interest of outcome
Study design		Randomized Controlled Trials, quasi-experimental	Other study designs
Study setting		Global	NA
Language		All languages	NA
Publication year		Not time bounded	NA
HIT- Health information technology, HIT- diabetes mellitus	NA- Not applicable	T1DM- type 1	diabetes mellitus, T2DM- type 2

TABLE II

## SUBGROUP ANALYSIS OF PRIMARY MEDICATION ADHERENCE

Subgroups	Categories	Number of studies	Sample size (IG vs CG)	Relative redemption difference (%)	95% CI	I <sup>2</sup> (%)	p-value
Type of provider of intervention	Pharmacist	1	221 vs 199	8	2-14	NA	NA
	GP	1	521 vs 493	21	16-26	NA	NA
	Nurses	1	148 vs 142	-2	-6-3	NA	NA
	Healthcare team	1	481 vs 458	-2	-12-8	NA	NA
Intervention setting	Institutional	2	629 vs 600	-2	-2-6	0	0.998
	Community	2	742 vs 692	17	13-21	91.1	0.001
Intervention period in months	Less than six	2	369 vs 341	4	-1-9	65.2	0.009
	Greater than six	2	1002 vs 951	10	7-13	97.8	<0.001
IDF region	Europe	1	521 vs 493	21	16-26	NA	NA
	NAC	3	850 vs 799	1	-1-3	70.7	0.033

CG- control group, IG-intervention group, NA-Not applicable, NAC- North America and Caribbean



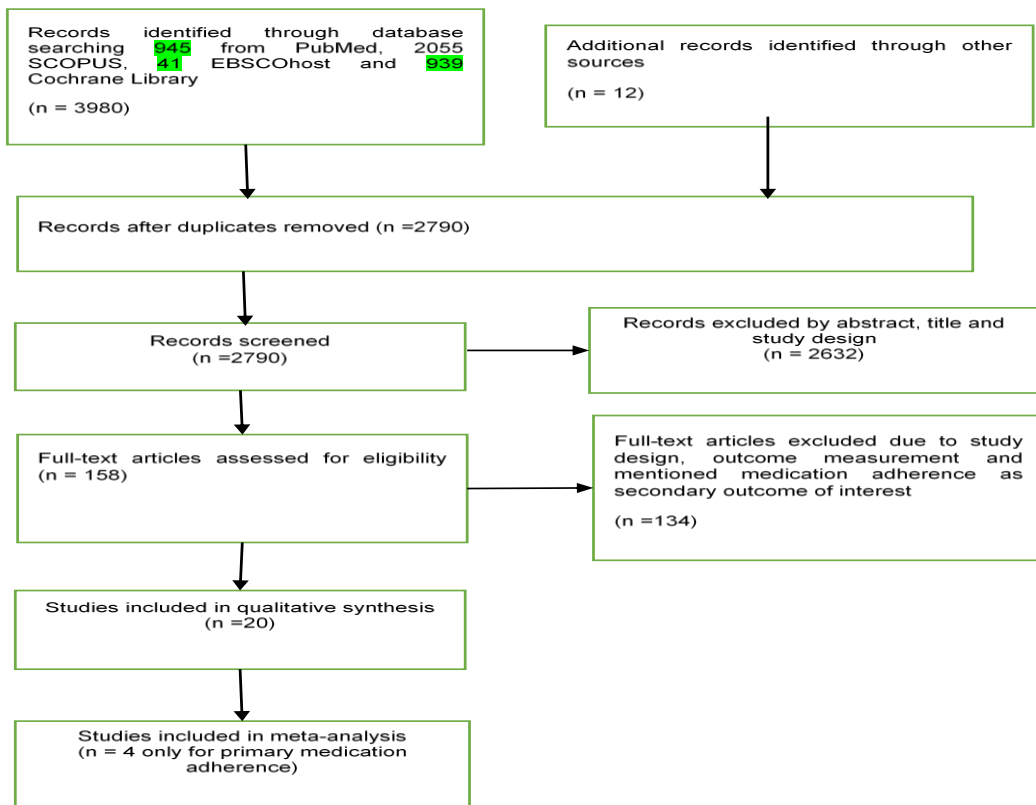


Figure 1 Study characteristics of primary Medication adherence among T2DM

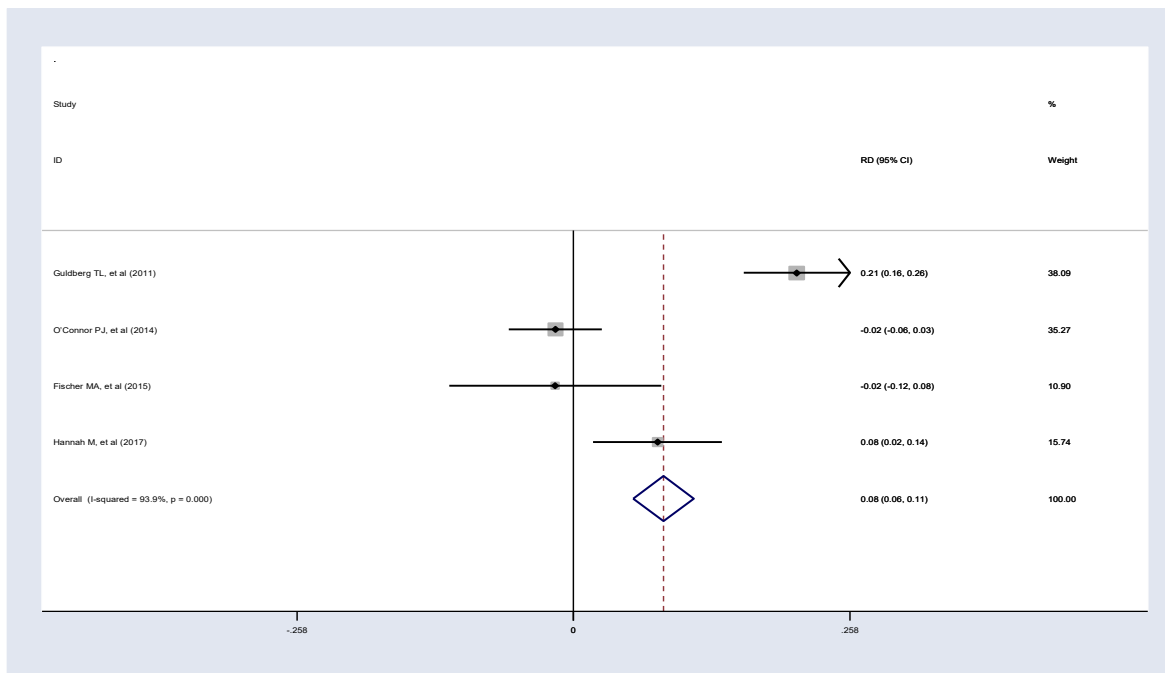


Figure 2 Forest plot for the overall effectiveness of public health interventions on primary medication adherence of included trials

# Factors Affecting Oral Health Service Utilization of Differently-Abled School Children in Kathmandu, Nepal

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## ABSTRACT

**Introduction:** Dental caries and gingivitis are the prominent oral diseases among children with social disadvantage such as differently-abled children. Oral health service utilization (OHSU) of these children can be even more challenging. This study evaluates the prevalence of dental caries and gingivitis and determines the factors affecting OHSU of the differently-abled school children in Kathmandu, using the Anderson health care utilization model.

**Methodology:** A cross-sectional study was conducted in the schools in Kathmandu that enroll the differently-abled children from which a total of 400 school children aged 7-18 years old were randomly selected for the study. The children's oral health status was examined by a dentist. Data on predisposing factors, enabling factors, and need factors of the children were collected from their legal guardians, using a self-administered questionnaire. A multiple logistic regression model was performed to assess the association of the predisposing, enabling, and need factors with OHSU.

**Results:** The prevalence of dental caries and gingivitis of the children was 86.16% and 52.83% respectively. The OHSU of the children is associated with a range of enabling factors including, good oral health knowledge of parents (OR=12.63; 95%CI=3.14-50.76), good oral health behaviors of the parents (OR=11.3; 95%CI =1.01-04.91), and service affordability (OR=5.25, 95%CI=1.51-18.21). Among need factors, only toothache shows a significant increased use of oral health services (OR=9.53, 95%CI=2.15-42.27). The analysis does not find any associations between the predisposing factors and OHSU.

**Conclusion:** Differently-abled children school children in Kathmandu are facing with an extremely high prevalence of dental caries and gingivitis. It is also found that the parental socioeconomic status and the children's oral health status play a significant role in the use of oral health services. The findings suggest that oral health education for parents and differently-abled children is necessary to promote the increased use of oral health services and thus, reduce the prevalence of dental caries and gingivitis among the differently-abled school children.

**Key-words:** oral health service utilization, dental caries, gingivitis, differently-abled school children

# Health Literacy Among University Students: Relationship With Sociodemographic Characteristics

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## ABSTRACT

Health Literacy (HL) conditions the way in which the individual is able to make the right decisions about health, affecting the quality of life, which may have implications for the expenses of Health Systems. So monitor HL it is a relevant tool in Health Promotion. This study aims to analyse the relationship between HL and the sociodemographic characteristics of students. This is a descriptive-correlational, cross-sectional study with a quantitative approach, with a sample of 351 university students. In collecting data we used a questionnaire filled out by students online. Data were processed using SPSS software (version 22.0). The majority of students were female (69.5%), belonged to the age group of 18 to 23 years (72.4%), attended a degree (65.1%) and reported a monthly income per capita between 1000 and 1999 euros (37.3%). The HL categories differed significantly between genders ( $\chi^2$ :  $p < 0,041$ ) and among students with different per capita income ( $\chi^2$ :  $p < 0,049$ ). The HL of students in this sample is predominantly limited and is related to gender and per capita income. In view of an identified low level of HL, there is a need for investment in health education in this population group.

**KEYWORDS:** Health Literacy; University students; Public health; Health Education; Healthy decisions.

# 1 INTRODUCTION

Health Literacy (HL) is a relatively recent concept, which was introduced in the 1970s of the last century, but has been gaining increasing importance in public health over time. This phenomenon is concerned with people's ability to assertively respond to the increasingly complex health demands in a society in constant transformation [1; 2].

The importance of this topic began to emerge when it was found that HL levels condition how citizens are or are not able to make correct decisions about their health, affecting, the quality of life of individuals, as well as those who depend on them. This importance, however, is not limited to the individual level, but covers the social level, having implications for health systems' expenses [3].

The World Health Organization (WHO) first defined HL as the set of cognitive and social skills that determine individuals' motivation and ability to access, understand and use information in order to promote and maintain good health. It implies the acquisition of knowledge, personal skills and confidence to act in a healthy way, through changes in lifestyle and living conditions [4].

Already in the 21st century, this author [5] conceptualized this concept as "the awareness of the person learning and acting in the development of their understanding, management and investment skills, favourable to health promotion" (p. 95).

Even more recently, HL has been defined as the ability to deal with health information, specifically, people's knowledge, access, understanding, interpretation, evaluation, application and use, promoting in the individual the personal management of their health status, so that they are able to make decisions regarding health care, disease prevention and health promotion, in their daily lives, in order to maintain or improve their quality of life, in various situations, throughout the life cycle [6; 3].

The author [7] linked the concept of HL to the notion of empowerment and outcomes in health education, and classified HL in a sense of increasing autonomy through three levels: i) Functional (basic) literacy: characterized by sufficient skills to read and write, allowing the individual to function effectively in their daily life activities; ii) Interactive (communicative) literacy: composed of cognitive and more advanced skills, which can be used in conjunction with social skills to obtain and interpret information through various sources of communication; iii) Critical literacy: consisting of more advanced cognitive skills that, in conjunction with social skills enable critical analysis of the information acquired, which is essential for responsible decision making about the various events of everyday life.

HL differs from health education (HE), since the latter allows increasing individuals' awareness of the social determinants of health, guiding actions that promote their modification, while HL is the result of HE [7]. In the opinion of this author [8], the concept of HL is distinguished from the concept of HE, because while HE aims to improve knowledge about health, HL allows for the understanding and application of knowledge, a view which we consider somewhat reductive about the role of HE.

The National School Health Programme (PNSE) of Portugal, following the objectives and strategies of the National Health Plan (NHP) - Revision and extension 2020, aims at achieving greater health gains, with the objectives of promoting healthy lifestyles and improving the HL level of the educational community [9]. To this end, it is necessary to focus on the effective empowerment of citizens in the National Health Service and health organizations as well as the professionals who train them [10].

According to WHO [11], limited HL is associated with lower participation in the process of health promotion and disease prevention of individuals. In turn, an inadequate level of HL is related to late screening activities, higher-risk health choices (such as higher rates of tobacco use), more accidents at work, poor management of chronic diseases (such as

diabetes, asthma and HIV infection), low adherence to medication, medication errors, misdiagnosis due to poor communication between providers and patients, increased rates of hospitalization and readmission, growth in premature morbidity and mortality.

Other author [12] reinforces that low HL is also associated with higher and longer hospitalisation rates over time, and ineffectiveness in dealing with emergency situations, which ultimately affects the doctor-patient relationship.

In terms of economic cost, the United States National Academy in 1998 estimated that the additional health care costs caused by HL limitations were about \$73 billion. In Canada in 2009, limited HL cost over \$8 billion [11].

In turn, in Europe millions of euros are spent on health care, and it is estimated that the costs of low HL may account for 3% to 5% of the total health care costs in the health care systems of countries on this continent [13].

Some studies have been conducted at the international level [14; 15], which sought to analyze the relationship between the level of HL and the sociodemographic characteristics of university students, in order to identify some factors related to that phenomenon, in which a relationship was found to exist with gender, household monthly income, and risk behaviors (alcohol consumption).

For all this, HL is considered a relevant tool to prevent diseases and complications, promote health, improve the level of quality of life, as well as assist in the ability and motivation for healthier choices [16; 2].

This study arose within the scope of this topic, with the general objective of analysing the relationship between HL and the sociodemographic characteristics of university students in Northern Portugal.

There are some international studies that analyse the relationship between this phenomenon and sociodemographic characteristics, but they are practically non-existent in Portugal, including the geographical area of this student population.

## **2 METHODOLOGY**

The methodological component is a key aspect in any research process, since it serves as a guide during the development of research, guiding the researcher to find answers to specific questions and, thus, acquire new knowledge.

This is an observational, descriptive-correlational and cross-sectional study of quantitative approach [17; 18].

### **2.1 Participants**

The population of a study is defined by the inclusion criteria. The inclusion criteria were: i) Being a student of a higher education institution in the Northern region of Portugal, in the 2018/2019 academic year; ii) Being aged 18 years or more. The population was composed of 1317 university students.

The sample is the fraction or subset of a population selected and on which the study is performed, and should be representative of the population, being defined by the exclusion criteria. We established as exclusion criteria: i) Students who were not present on the date of data collection; ii) Students who did not complete at least 80% of the questions. This is a non-probability convenience sample. The sample was composed of 351 students who attended the institution which was the context of this study, around 26.7% of the population.

Of the total sample (n=351), most were female (69.5%), aged between 18 and 23 years (72.4%), attending a degree course (65.0%) and the largest group of students (37.3%)

reported a household net monthly income per capita between 1000 and 1999 Euros (**Table 1**). The mean age was  $23.54 \pm 7.43$  years, the minimum was 18 years and the maximum 54 years of age.

Table 1 Sociodemographic characterization of the sample (n = 351)

Variables		Af	Rf (%)
<b>Gender</b>	Female	244	<b>69.5</b>
	Male	107	30.5
<b>Age group</b>	18-23 years old	254	<b>72.4</b>
	$\geq 24$ years old	97	27.6
<b>Study cycle</b>	Superior Technician Course	37	10.5
	Licence degree	228	<b>65.0</b>
	Master degree	86	24.5
<b>Monthly income</b>	Less than 500 Euros	61	17.4
	Between 500-999 Euros	123	35.0
	Between 1000-1999 Euros	131	<b>37.3</b>
	$\geq 2000$ Euros	36	10.3
<b>Total</b>		351	<b>100</b>

Legend: Af – Absolute frequency; Rf – Relative frequency.

## 2.2 Material

For data collection, we used a self-completion questionnaire designed for this purpose. It was validated for this population through a pre-test previously applied to a group of eight students with very similar characteristics to our target population. The questionnaire was organized into three parts: the first part included a group of questions for sociodemographic characterization; the second part integrated the European HL Scale (HLS.EU-EN) to assess the participants' level of HL; finally, the third part included questions about the perception of health status and use of health services. This article reports only on the first two parts.

The HLS-EU-PT Scale was translated and validated for the Portuguese population by research team [19], with items with five response options (Very Difficult, Difficult, Easy, Very Easy, and Don't Know/No Answer). These response options are scored, 1, 2, 3, 4 and zero points, respectively. This construct has 47 items and the score ranges between 0 and 50 points. A higher score corresponds to a better level of HL. To calculate the HL Index (HLI) the following formula was applied:  $LS\ Index = (mean - 1) * (50/3)$ . The authors defined the cut-off points that limit the four HL categories: i) Inadequate (0-25); ii) Problematic (>25-33); iii) Sufficient (>33-42); and iv) Excellent (>42-50). This scale has three dimensions: Health care, Health promotion and Disease prevention.

## 2.3 Procedures

During the data collection procedure of this research, the right to self-determination, intimacy, anonymity, confidentiality, as well as voluntary participation were safeguarded [17]. Ethical principles were respected in accordance with the Helsinki Convention. In order

to collect data, a request for authorization was made to carry out the study to the Ethics Committee of the University of Trás-os-Montes and Alto Douro which gave a favourable opinion (n°38/2018 September 10) and the Director of the School, who also authorized it.

The data collection process was performed via email, through a hyperlink, which referred to the anonymous self-completion questionnaire that could be answered online. This was sent by the Academic Services of the School in which this study was conducted, thus ensuring the required anonymity throughout the process, and the researchers did not have access to the participants' email address. This questionnaire was developed through Google® Forms and the participants' answers were sent to the researchers. The data collection period took place from October 23 to November 26 of 2018.

The data processing was made by SPSS Software (24.0). We used descriptive statistics, with absolute and relative frequency and mode calculations for all variables and the mean and standard deviation for the variables of measurement level ratio. We also used inferential statistics, using “ $\chi^2$ ” test to compare the HL category distributions. We considered the 5% as a level of significance [20].

### 3 PRESENTATION AND DISCUSSION OF RESULTS

The presentation of results includes the measures of central tendency and dispersion of the HL index and its three dimensions, then the distribution of absolute and relative frequencies of the HL categories and, finally, the results of the statistical tests between HL and sociodemographic characteristics, which allowed us to assess the existence of relationships between these variables.

#### 3.1 Health Literacy

Of the total sample (n= 351), the mean HLI ranged from 31.17 points of the HLI of the "Disease Prevention" Dimension to 31.47 points of the HLI of the "Health Care" Dimension. The median of the HLI had the same trend. The minimum value of the HLI was zero and the maximum value was 50 points (**Table 2**).

Table 2 Measures of central tendency and dispersion of the Global HLI and its dimensions

Variables	Mean	SD	Median	Minimum	Maximum
Global Health Literacy Index	31.30	8.19	30.85	0	50
Health Literacy Index of the Health Care Dimension	31.47	8.08	31.25	0	50
Health Literacy Index of the Disease Prevention Dimension	31.17	8.99	31.11	0	50
Health Literacy Index of the Health Promotion Dimension	31.26	9.45	31.25	0	50

Legend: SD – Standard deviation

The highest percentages of the HLI categories were in the Problematic category, both in the Global HLI and in all indices of the HL dimensions. The highest value in that category



was in the Global HLI (47.9%) and the lowest in the HLI of the Disease Prevention Dimension (34.8%). The percentages of the HLI category Inadequate were in all HLIs higher than those of the HLI category Excellent (**Table 3**). Grouping the two lower HL categories into the designated 'Limited Health Literacy' category and the two higher categories into the 'Unlimited Health Literacy' category found that most students (> 57%), fell into the 'Limited Health Literacy' category in both the Global HLI with all dimensions.

Table 3 Distribution of frequencies of Global HLI categories and their dimensions

Variables	Inadequate		Problematic		Sufficient		Excellent	
	Af	Rf	Af	Rf	Af	Rf	Af	Rf
Global Health Literacy Index	65	8.5	168	47.9	77	21.9	41	11.7
Health Literacy Index of the Health Care Dimension	72	20.5	138	39.3	106	30.2	35	10.0
Health Literacy Index of the Disease Prevention Dimension	78	22.2	122	34.8	104	29.6	47	13.4
Health Literacy Index of the Health Promotion Dimension	83	23.6	125	35.6	91	25.9	52	14.8

Legend: Af – Absolute frequency; Rf – Relative frequency.

### 3.2 Relationship between Health Literacy and sociodemographic characteristics

There were no statistically significant differences between the proportions of the categories of the Global HLI of students with different age group ( $\chi^2$ :  $p \geq 0.765$ ) and of students attending different study cycles ( $\chi^2$ :  $p \geq 0.171$ ).

The proportion of the Global HLI categories differed significantly among students of different gender ( $\chi^2$ :  $p < 0.041$ ), with female students obtaining an Adjusted Residual (AR) of + 2.4 cases than expected in the HL Sufficient category, with a percentage of 25.4% in this category versus 14.0% of males. In turn, male students obtained an AR of +2.0 cases than expected, in the HL Excellent category, with a percentage of 16.8% versus 9.4% of females. Females fell more into the HL Sufficient category, while males fell into the HL Excellent category.

The proportion of the Global HLI categories differed significantly among students who had different monthly household income ( $\chi^2$ :  $p < 0.049$ ), with students whose household was between 1000 to 1999 getting an AR of -2.4 cases than expected in the HL Problematic category with a percentage of 39.7% and +2.2 cases than expected in the HL Sufficient category, with a percentage of 28.2% versus an AR of -2.1 cases than expected and a percentage of 11.1% in the HL Sufficient category and 55.6% in the HL Problematic category of students whose household had a per capita Income between 250 and 499 Euros. That is, the former students fall more into the HL Sufficient category than the latter, who fall more into the HL Problematic category (**Table 4**).



Table 4 Relationship between Global Health Literacy and sociodemographic characteristics

Sociodemographic variables	Global Health Literacy index categories				Test value	P value			
	Inadequate AR	%	Problematic AR	%			Sufficient AR	%	Excellent AR
<b>Gender</b>									
Female	-0.7	17.6	-0.2	47.5	<b>+2.4 5.4</b>	<b>-2.0 9.4</b>	$\chi^2=8,247$	<b>0,041</b>	
Male	+0.7	20.6	+0.2	48.6	<b>-2.4 14.0</b>	<b>+2.0 16.8</b>			
<b>Age group</b>									
18-23 years old	+0.3	18.9	+0.6	48.8	-0.2 1.7	-1.0 10.6	$\chi^2=1,150$	0,765	
≥ 24 years old	-0.3	17.5	-0.6	5.4	+0.2 2.7	+1.0 14.4			
<b>Study cycle</b>									
Superior							$\chi^2=9,053$	0,171	
Technician Course	+0.1	18.9	-2.0	32.4	+2.1 5.1	+0.4 13.5			
Licence degree	+1.4	20.6	+1.1	50.0	-1.9 8.9	-0.9 10.5			
Master degree	-1.6	12.8	+0.2	8.8	+0.6 4.4	+0.8 4.0			
<b>Monthly income</b>									
Less than 500 Euros	+1.5	25.9	+1.2	55.6	<b>-2.1 1.1</b>	-1.1 7.4	$\chi^2=21,003$	<b>0,049</b>	
500-999 Euros	-0.5	17.1	+0.3	48.8	+0.5 3.6	-0.5 10.6			
1000-1999 Euros	-0.1	18.3	<b>-2.4 39.7</b>	<b>+2.2 8.2</b>	+0.9 13.7				
≥ 2000 Euros	-1.7	8.3	+1.7	61.1	-1.2 3.9	+1.0 16.7			

Legend: AR – Adjusted Residual;  $\chi^2$  – Qui-square.

The results showed that there was a predominance of female students (69.5%) compared to male students, which coincides with the data from the Directorate-General of Higher Education of 2017 that identify 46.2% males and 53.8% females in higher education [21]. The results also converge with the studies conducted by Espanha et al. [3] and Pedro et al. [22] and other researcher [23], in which the sample was mostly composed of female elements.

On the other hand, 27.6% of the sample under study was aged 24 years or more, which is similar to the data presented by the survey on the Registration of Registered Students and Graduates of Higher Education (RAIDES) [24], which mentions that 24% of higher education students are in this age group.

Regarding the monthly per capita household income of the students in the sample, the largest group of participants mentioned values between 1000 and 1999 euros per month, i.e. they present values higher than the national averages [25]. These data can be justified by the region of coverage of the institution in the north of the country, is located in a very industrialized area, where exports are predominant, reporting a growth of 60% in the last three years, with the creation of two thousand jobs [26].

With regard to HL, for the sample under study, the average obtained in the Global HLI reveals a problematic HL level, but, almost at the limit of a sufficient HL, with an average of 31.3 points. The results show that 66.4% of respondents had Limited HL (inadequate or problematic HL). These results are in line with those reported by Pedro et al. [22] when the authors mention that, in Portugal, approximately 61% of the surveyed population presents a level of Global HL in problematic or inadequate health, with a mean Global HLI of 31.5. Similar results were obtained in Silva's [23] research, where the mean Global HLI was 32.15, with more than 50% of the participants presenting Limited HL. However, in the present study, it was expected that, in the case of Higher Education students, the results would be better. This fact may be explained by the fact that all students did not attend health courses,

are a healthy group, do not attend health services regularly, and do not participate in health education programs, which may justify some lack of knowledge in this area.

#### 4 CONCLUSION

The profile of the students in the sample is characterised by being female students, aged between 18 and 23 years old, attending an undergraduate course and by their household having a per capita monthly income between €1000 and €1999.

The average Global HLI of the students reveals Problematic HL levels, with most students presenting a Limited HL. This level is similar to that of other studies conducted with the general population. A higher level of HL was expected, which did not happen in this study.

We found that there is a relationship between the categories of the Global HLI and gender, as well as with the per capita monthly income of the household.

This study contributed to knowing the HL level of this sample of students, having highlighted the need for health services to intervene in this population of students, with the purpose of increasing their HL, empowering them to manage their health and that of this student community, thus achieving health gains.

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# ***In Vivo* Antimalarial Activity of 80% Methanol and Aqueous Bark Extracts of *Terminalia brownii* Fresen. (Combretaceae) against *Plasmodium berghei* in Mice.**

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## Abstract

Despite substantial scientific progress over the past two decades, malaria continues to be a worldwide burden. Ever growing resistance towards the currently available antimalarial drugs is a challenge to combat malaria. Medicinal plants are a promising source of new drugs to tackle this problem. Thus, the present study aimed at evaluating the antiplasmodial activity of *Terminalia brownii* in *Plasmodium berghei* infected mice. A 4-day suppressive test was employed to evaluate the antimalarial effect of 80% methanol and aqueous bark extracts of *T. brownii* against *P. berghei* in Swiss albino mice. The *in vivo* acute toxicity test indicated that both extracts did not cause mortality. The 4-day test revealed that the 80% methanol and aqueous extracts exhibited significant inhibition of parasitemia compared to negative control. The maximum level of chemo suppression (60.2%) was exhibited at 400 mg/kg dose of 80% methanol extract. Moreover, the 80% methanol extract showed a significant attenuation of anemia associated with infection in a dose-dependent manner. The aqueous extract, on the other hand, exhibited a percent inhibition of 51.1% at the highest dose (400 mg/kg/day). The present study indicated that hydromethanolic and aqueous bark extracts of *T. brownii* possess a promising antimalarial activity.

**Keywords:** *Terminalia brownii*, 80% methanol extract, aqueous extract, antimalarial, mice, *plasmodium berghei*.

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# Iron Fortificants & Pre-Biotics significantly improve Serum Folate Levels in Iron Deficient Women of Reproductive Age

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The present research was designed to evaluate the combined effects of iron fortificants and prebiotics on serum folate levels among iron deficient women of reproductive age.

To serve this purpose, a double blind randomized control study was designed involving n = 75 iron deficient women of reproductive age group. These women were divided into 5 groups, each having 15 subjects. One group was control while other four were treatment groups. They were given varying combinations of iron fortificants and prebiotics on daily basis for 90 days. Iron fortificants included ferrous sulphate and sodium iron EDTA while prebiotics consisted of Inulin and galacto-oligosaccharides. Overnight fasting blood samples were taken from women at baseline, 30<sup>th</sup>, 60<sup>th</sup> and 90<sup>th</sup> days, respectively. Mean square values for serum folate levels showed that there were significant variations for the effect of groups, study intervals as well as the interaction between groups and study intervals (P-value < 0.05).

Our current study concluded that iron fortificants and prebiotics when combined, could significantly improve serum folate levels among women of reproductive age. This particular potential of prebiotics could further be exploited to address the global health issue of iron deficiency anemia, effectively.

Keywords: Iron Fortificants, Prebiotics, Serum Folate, Iron Deficiency, Anemia, Women of Reproductive Age, Public Health

# Maximizing the Potential of Paraprofessional Listeners to Promote Psychological Wellbeing during COVID-19

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## Abstract

It is already well established that pandemics in general and the COVID-19 one in particular can have adverse consequences on some people's mental well-being. While not everyone will suffer and some may even benefit from the pandemic conditions, having emotional support can reduce the likelihood of poor outcomes and promote psychological wellbeing.

Professional mental health networks are understaffed to give adequate support to the number of distressed individuals at this time. Furthermore, there are barriers for many to access professional help. There is empirical support that caring and empathic paraprofessional laypeople can quickly learn Psychological First Aid to reduce the distress load of the general population during pandemics. There are already platforms such as *7-Cups* and Johns Hopkins University that provide free evidence based training for volunteer paraprofessionals. The first author participated in these programs in order to gain competencies as a paraprofessional listener and began providing voluntary support during the current pandemic. First, she outlines the need for such services by describing conditions in Thailand. Next, she shares her experiences of the process of gaining the training and providing services. The second author, a mental health professional, addresses some of the benefits of having paraprofessional listeners along with some important considerations. Promoting such listening programs to the public could have positive societal implications and should be implemented widely with some precautions to ensure professional, competent and ethical services.

*Keywords:* COVID-19 Pandemic, paraprofessional listening, psychological wellbeing, Thailand

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## **Maximizing the Potential of Paraprofessional Listeners During COVID-19**

Before I address how we can maximize the potential of paraprofessional listeners during COVID-19, let me tell you why it is important by describing some of the situations that have been occurring from the eye of a Thai citizen. I will not comment on what is reported in the media as we all know that they need to exaggerate or take sides sometimes as that is part of their jobs. I will only speak from my own personal experiences and from people in my circles who have shared with me.

Many months ago, Thailand was one of the countries that could manage well during this pandemic. We had very low new COVID-19 cases and a low (almost zero) death rate. This was thanks to the Thai people who seemed to be pretty cautious, some overly so to the point of panic. Since the pandemic started, we barely saw anyone out of their own homes not wearing a mask. Masks became a natural part of our body. Alcohol gel overnight became something as important as our wallets when we leave home.

However, the nightmare started because there were some groups who threw parties that included so many people in closed areas despite the warnings from lots of media about the new variant that could spread much faster and is more dangerous for all ages. In addition to that, in regards to our land borders, Facebook advertisements have been seen stating that if anyone pays a certain amount of money, they will bring laborers back to Thailand (without having to quarantine) after having crossed to work in our neighboring countries. As one of the early preventative measures, Thailand's borders have been closed since Spring 2020 and no one can legally enter without going through a mandated 14-day state quarantine.

Only a few weeks after these two topics were the talk of the town, things started to get worse and worse. Many new clusters were found. It went from hundreds of new cases to thousands, and now, in August 2021, there are more than 18,000 new cases each day. There are a lot of serious cases that need to be in the ICU and stay much longer and many that could not make it out of the hospitals.

I know these are things that you might not need or want to hear about. However, without hearing what we are going through, then it would be more difficult to understand why we need more people to be trained as paraprofessional listeners.

Here is the part that I myself struggled with as a Thai citizen. First, there are problems with vaccines. It turned out that the order was approved too slowly and that the company also could not deliver as many doses as agreed upon. When some did arrive, the vaccines were given to public health frontline workers, people aged 60+, and at-risk people with 7 types of serious illnesses. This prioritizing system is fair enough. After I booked appointments for my parents to get vaccinated which took almost a week to get the online system to work and receive a confirmation, the government changed their priority to save working-age adults as they might be able to open the country faster if the workers are safe. So the application for the elderly was closed and my parents' bookings were postponed. Then working-age people who registered could get two doses quickly. I registered as well but the earliest availability was a month away. Many of my cousins and people at my office still could not even find a place to book vaccine appointments.

About a week later, when the death rate continued to rise and it was confirmed that those deaths were mostly among the elderly, they closed the application for working-age people and postponed their bookings until an unspecified date. Can you imagine how first the elderly and then the working-age folks are feeling? Not to mention how the healthcare frontline workers feel seeing the number of new cases rising everyday with more people dead and they themselves got two doses of a vaccine that had not even been approved yet by the World Health Organization. Then I heard from the media that many people died after



receiving the shots. However, they could not get insurance payouts because nobody could confirm (or dare to) that the death was caused by the vaccine.

Then, while we were losing hope waiting for the who-knows-when vaccine, we tried to book appointments in other places even though we would have to pay for it. The sad part is even when private hospitals tried to obtain vaccines, they had to wait for the Central Medical Department to approve it. Money cannot buy your life in this case. The saddest part is now we are under a lockdown again, many businesses are dying, and some people are dying at home possibly related to lack of resources, infrastructure, and access to COVID-19 tests. People are watching their families die because there are not enough hospital beds nor equipment for the amount of people who got COVID-19, and hotlines are too busy and not available to reach out to.

If you have read up to here, I believe that you are starting to feel what we feel. It is not about placing blame; it is about figuring out how to support each other in the best ways possible. Every day I talk to many people: family, friends, and the people from my listening sessions. I also offer to be an ear for those people who comment on social media that they do not want to live like this anymore. If you could see the number of such comments, you would realize that even if I were a robot who could listen to people and offer them a safe space 24/7, it still would not be enough.

During these difficult times when so many are struggling financially, who can afford to see a professional counselor? Let's say there are some people who can afford it, but how long do they have to wait before their first appointment? The minimum time I know of is a month. You have to wait a month to talk for 45 minutes! Imagine how much happens in a month. Who could survive until that time? If they do not get COVID-19, they might end up committing suicide.

## **How Paraprofessional Listeners Can Help Reduce the Mental Health Impact**

Writing about these circumstance is not to blame anyone because there is no point nor benefit in doing that. What I strongly recommend is that we need to collaborate with psychological/health professionals and quickly train local people to be voluntary listeners as fast and as many as possible. This will not only help others who are in distress but, if the ones who are hopeless themselves can shift their focus to help others, they will be much more hopeful and feel their lives are more valuable, appreciated, and have meaning. This is one effective way to prevent negative mental health consequences (e.g., suicide rate) from drastically rising during the COVID-19 pandemic. As a paraprofessional active listener myself who saw many pandemic related changes in the people I supported, I believe we need to take action fast enough to not let a nightmare become a tragedy.

Becoming a better listener is easy, either free or very cheap, and can be learned rather quickly. Let me briefly discuss how I became an effective listener and what my experiences are. For a long time, I often had people coming to talk to me and share things they did not share with others. Back then, I thought of myself as a secret keeper. One day, this happened again. However, because I was close to the person who shared with me, I got too emotionally involved. Since I was not trained, I did not know how to emotionally distance myself enough to help them like professional counselors do. While I was interested in becoming a counselor at the time, I was hesitant to get a Master's Degree in counseling right away because I was not sure if I really liked it enough and, even if I did, I thought it would take too long before I could start helping anyone.

That spurred me to start searching for volunteer listener opportunities. I found 7cups.com which is a U.S. based online chat support service where they allow anyone to be a listener as long as we can pass their tests. So, I completed all of their free online courses and

did almost all the tests available while at the same time supporting people from across the globe during the COVID-19 pandemic.

These people come to me with different issues such as depression, domestic abuse, stress, OCD, relationship concerns, and loneliness, among other reasons. There were a lot of people that were feeling depressed and lonely from the lockdowns in their countries. Others could not adapt to the sudden loss of social interactions and needed someone to chat with. Some lost their jobs and businesses.

One challenge for me is that the background data about those seeking support is not given. So, I do not know any of the person's intersecting identities such as gender, age, race, socioeconomic status, sexuality, etc. or even their name, unless they tell me. I really have to pay 100% attention to every word they say while trying to understand the situation fast enough to respond. I have to memorize important details because the chat history will be automatically deleted by the system for security purposes. On a positive note, it is also good because there is no precipitating judgement nor bias when you know nothing at all about the person you are talking to.

Besides improving listening skills through online trainings offered by platforms like 7 Cups, there are also Psychological First Aid trainings available (some online, some in person). Such trainings are also often free and can enhance one's ability to be a more effective supporter of those who might be struggling. Recently, I took a free online Psychological First Aid course from Johns Hopkins University. Its emphasis is on training local people to be listeners to support people in acute distress. The course applies mostly to natural disasters, but the information can easily be adapted to pandemic related concerns. I applied the training to my own listening field by focusing on being the first line of psychological support available to people.

When people start to have some issues or distress, they feel very bad. Sometimes they know why but many times they do not quite understand the real cause because they focus more on how they feel. In some cases, they can reach out to their family or close friends, but some people find it difficult to impossible to share some topics with their loved ones or they might feel they are not understood. So, anyone could benefit from being trained to be a better listener to be able to better support their loved ones and strangers alike.

Listeners then can become the first line of support to those who may be struggling during this pandemic. Through active listening and asking effective questions, people can understand the issues better. Then together, they can try to find suitable solutions to reduce or get rid of their acute distress and plan for what to do in case it returns.

### **Benefits of Listeners as a First Line of Support**

- Almost anyone who is interested and has compassion in helping others can be quickly trained to do it
- Listeners reap psychological benefits when helping others
- People can come to a listener even for minor concerns (e.g., a small argument with their loved one or work stress)
- It is easier to reach out for support to a lay person in some cultures where seeking professional psychological support is still uncommon and stigmatized
- People might feel more comfortable recommending listening services if they feel listeners are more like friends rather than professionals because some people may feel embarrassed if others knew they see a counselor
- It is cheaper than professional help in terms of training listeners and fees for help seekers
- The waiting time to get support is less if there are enough listeners available

- It reduces the workload of health/psychological professionals who were already overburdened prior to the pandemic
- Health/mental health professionals can refer stable clients to listeners to reduce their workloads and also to reduce the cost of treatment for their clients
- It can prevent small issues from escalating and accumulating into more distressing, more difficult, and more time-consuming issues

### **Important Considerations**

- Some people may not be appropriate to be listeners (e.g., some people with certain personality disorders or ones that are overwhelmed by their own distress)
- The available trainings and tests must be aligned with ethical codes of health/mental health professional organizations
- There must be a clear protocol for when listeners should refer people to professionals (e.g., people who might need long-term treatment, those with mental health disorders causing significant impairment, people in crisis, and people with significant trauma histories)
- Listeners should be well versed in how to refer people to professionals
- Paraprofessional listeners should not deal with crisis cases like suicidal or homicidal ones
- There should be support for listeners such having a mentor or someone to consult with available when needed
- Confidentiality must be the golden rule for listeners

### **Conclusion**

In sum, training and supporting paraprofessional listeners can be another prong in the multipronged approach to reducing the adverse mental health consequences of the current pandemic. Health/mental health professionals and listeners can collaborate to support more people during these difficult times. Listening trainings and services should be promoted widely due to the potential societal benefits. Health/mental health professionals can assist in training listeners quickly with empirically backed resources.

Anyone can become a better listener and provide emotional support to those around them—their loved ones and strangers alike. We hope to see more local people around the globe being trained to be good listeners and—together with health/mental health professionals—we can educate people and make them feel more comfortable to seek support at early stages of distress. And when they do reach out, there will be more competent people ready to support them. If we know how to listen, be present and be empathetic with others, we can make positive changes and reduce the impact of the COVID-19 mental health pandemic.

### **Resources**

7 Cups [www.7cups.com](http://www.7cups.com)

John's Hopkins University Free Psychological First Aid Training  
[www.coursera.org/learn/psychological-first-aid/home/info](http://www.coursera.org/learn/psychological-first-aid/home/info)

# **PREANALYTICAL LABORATORY PERFORMANCE EVALUATION UTILIZING QUALITY INDICATORS BETWEEN PRIVATE AND GOVERNMENT-OWNED HOSPITALS AFFILIATED WITH UNIVERSITY OF SANTO TOMAS**

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## **ABSTRACT**

Recent evidences show that most of the laboratory errors are related to the pre-analytical phase, leading to erroneous results and diagnoses. The study focuses on the use of quality indicators (QIs) based on standards made by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) to identify and minimize errors occurring in the total testing process (TTP). Survey questionnaire was given to a random sample of nineteen respondents, eight from privately-owned and eleven from government-owned hospitals, who were mainly chief medical technologists, medical technologists, and laboratory supervisors from University of Santo Tomas (UST) affiliated hospitals. Pre-analytical QIs including misidentification errors, transcription errors, sample collection errors and sample handling and transportation errors were identified by the IFCC Working Group Laboratory Errors and Patient Safety (WG-LEPS). The data gathered were analyzed using Mann-

Whitney U test, Percentile, Linear Regression, Percentage, and Frequency. Results show high level laboratory performances on both private and government-owned hospitals. There is no significant difference between the laboratory performance of the two stated variables. Moreover, among the four QIs, sample handling and transportation errors contributed most to the difference. Outcomes indicate a satisfactory performance between both variables. However, in order to ensure high-quality pre-analytical step output and efficient laboratory operation, constant vigilance and improvements in pre-analytical QIs are still needed. Expanding the coverage of the study including other phases, additional quality indicators, different approaches in evaluating the performance level of the laboratories, and utilization of parametric tests are recommended.

**KEYWORDS:** Preanalytical phase, Quality indicators, Laboratory performance, Preanalytical error

## INTRODUCTION

Medical laboratory test results serve as an instrument for the diagnosis and decision-making of clinical doctors about their patients. According to studies, an estimated 60-70% of clinical decisions regarding a patient's diagnosis, prescription, hospital admission and discharge are based on laboratory test results (Abdollahi & Saffar, 2014). Hence, mistakes made in every step of the total testing process (TTP) can potentially harm and affect the patients' safety. This then gives importance to the identification and establishment of valuable quality indicators (QIs) which measure the processes, performance, and results in a healthcare setting reflecting the healthcare quality of a facility, and are used mainly to compare, measure, monitor, and improve their healthcare services or outcomes for the patients (Quentin et al., 2019). These indicators are crucial in ensuring that every step in the TTP is correctly performed and the best possible health outcomes are delivered. However, current QIs in the medical laboratory tend to focus on the efficiency of analytical processes, despite recent evidence suggesting that most errors occur outside the analytical phase (Plebani, 2012).

The TTP is traditionally divided into three main phases, specifically the pre-analytical phase, analytical phase, and post-analytical phase, in which the preceding phase directly affects the quality performance of subsequent series of activities.

The focus of this study, the Pre-analytical phase, is the first and starting phase wherein the process of test selection and ordering takes place, as well as the sample handling, identification, transportation and storage, from which when error occurs causes a significant decrease in the total quality of laboratory management, test results, and patient safety. The 70% error that this phase contributes to the overall laboratory performance was mainly due to human error and lack of harmonization within the process (Zemlin, 2017). Monitoring of this phase is critical particularly at this time of pandemic wherein the laboratory services are extremely puffed up especially the staff being forced to work in high throughput settings and under pressure and receive enormous workloads (Sheridan, 2020). Thus, to have an objective evaluation and monitoring of the critical aspects of its performance, the Quality Indicators (QI) are identified and established for quantifying the phase quality (Shahangian & Snyder, 2009).

With the goal of making a harmonized list of QIs, the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) standardized the reporting system of Quality Indicators by formulating a model that is derived from internationalized data (Lippi & Guidi, 2007). Furthermore, different programs and studies are continuously focusing on the refining and reshaping the quality of laboratory performance by means of better laboratory management and prevention and control of errors that will lead to assurance of providing accurate results for quality patient care and safety.

The aim of the study includes the monitoring, detection, and assessment of the pre-analytical errors in the laboratory process with the use of appropriate quality indicators, which could provide an avenue to redefine and improve the pre-analytical quality of the total testing process of clinical laboratories of private and government-owned hospitals affiliated to University of Santo Tomas. Along with other related studies, reasons for ensuring the highest quality, accuracy, and precision of laboratory outcomes benefiting and improving healthcare could be provided.

## RESULTS AND DISCUSSION

**Table 1.1 Preanalytical Laboratory Performance Evaluation of Private Hospitals on Misidentification Error**

Misidentification Error	Mean	SD	Verbal Interpretation
Number of misidentified samples	.004829	.0021422	High Level
Number of misidentified requests	.002243	.0007390	High Level
Number of samples with fewer than two identifiers	.005343	.0016582	High Level
Number of unlabeled samples	.001014	.0008071	High Level
<i>Overall</i>	.003343	.0009396	High Level

Results revealed that the *number of misidentified requests* was the highest (Mean = .005343, SD = .0016582). This is supported by a study conducted by Dudani et al. (2018) in which the common causes of errors for data entry in a private laboratory was due to incorrect or mismatched patient details, incorrect referring physician and patient demographic details, and mistaken type of test seen on patient request forms which accounted for 47% of the total preanalytical error. Additionally, according to West et al. (2017), an audit of request forms to identify the percentage which does not have complete information regarding the requester cannot be monitored or alert the laboratory workers immediately because an audit in the laboratory mostly does not provide real-time assessment of error incidence, but a survey of error rates at a particular point. This makes the audit not immediately alert users to the quality issues and true error rates with their misidentified requests. However, from the study conducted by Flegar et al. (2016), the highest error rates expressed in percentage under the



misidentification errors indicator were found for the number of misidentified samples, which was 0.06%, while the number of misidentified requests was 0.05%.

This indicates that the private hospitals are susceptible to errors associated with the number of misidentified requests among the misidentification error indicators for having the highest Mean = .005343 and SD = .0016582. However, it is below .05 or 5%, which indicates that the performance level of Private Hospitals is still generally high.

**Table 1.2 Preanalytical Laboratory Performance Evaluation of Private Hospitals on Test transcription Error**

<b>Test transcription Error</b>	Mean	SD	Verbal Interpretation
Number of outpatients requests with erroneous data entry (test name)	.006229	.0023690	High Level
Number of outpatients requests with erroneous data entry (missed test)	.001371	.0008616	High Level
Number of outpatients requests with erroneous data entry (added test)	.001471	.0010436	High Level
Number of inpatients requests with erroneous data entry (test name)	.000771	.0005648	High Level
Number of inpatients requests with erroneous data entry (missed test)	.001057	.0008904	High Level
Number of inpatients requests with erroneous data entry (added test)	.001786	.0007244	High Level
<i>Overall</i>	.002114	.0007290	High Level

Among the six indicators of test transcription errors, the *number of outpatients requests with erroneous data entry (test name)* was the highest (Mean = .006229, SD = .0023690). This is supported by a study conducted by Plebani et al. (2017), where an order of priority has been assigned based on the importance of the specific indicator developed by IFCC and the difficulty of data collection with one as the highest priority and four as the lowest. The QIs with priority one is mandatory and to be put into practice first. The number of outpatients requests with erroneous data entry (test name) indicator is one of the quality indicators assigned as priority one due to its difficulty maintaining proper laboratory data collection and being prone to errors.

This indicates that the private hospitals are susceptible to error associated with the number of outpatients requests with erroneous data entry (test name) among the test transcription error indicators for having the highest Mean = .006229 and SD = .0023690.



However, it is below .05 or 5%, which indicates that the performance level of Private Hospitals is still generally high.

**Table 1.3 Preanalytical Laboratory Performance Evaluation of Private Hospitals on Sample Collection Error**

Sample Collection Error	Mean	SD	Verbal Interpretation
Number of samples of wrong or inappropriate type	.005800	.0036647	High Level
Number of samples collected in the wrong container	.003443	.0008304	High Level
Number of samples with insufficient sample volume	.003643	.0011886	High Level
Number of samples with inappropriate sample-anticoagulant volume ratio	.001800	.0026026	High Level
Number of contaminated samples	.002343	.0008867	High Level
Number of hemolyzed samples	.011629	.0034422	High Level
Number of clotted samples	.009986	.0081881	High Level
<i>Overall</i>	.005500	.0025826	High Level

Likewise, among the seven indicators of sample collection errors, the *number of hemolyzed samples* was the highest (Mean = .011629, SD = .0034422). This is supported by the study conducted by Chawla et al. (2012), where hemolyzed samples are the most common causes of sample rejection, with a result of 7 per 1000 samples. In another study conducted by Rizk et al. (2014), the number of clotted samples were also second to the highest on both before and after laboratory performance improvement with the results of 1,584 hemolyzed samples out of 2,314 total samples rejected in phase I, a phase which included data collection for evaluation of the existing process. In phase II, including data collection for evaluation of the process after improvement, 841 hemolyzed samples out of 1,285 total samples were rejected. However, from the study conducted by Arul et al. (2018), from the overall prevalence of preanalytical errors found in 0.43% of the total number of samples received, the most common preanalytical error was inadequate samples followed by clotted samples, diluted samples, and hemolyzed samples having overall frequencies of preanalytical errors of 0.2%, 0.12%, 0.02%, and 0.03%, respectively.

This indicates that the private hospitals are susceptible to error associated with the number of hemolyzed samples among the sample collection error indicators for having the highest Mean = .011629 and SD = .0034422. However, it is below .05 or 5%, which indicates that the performance level of Private Hospitals is still generally high.

**Table 1.4 Preanalytical Laboratory Performance Evaluation of Private Hospitals on Sample Handling and Transportation Errors**

<b>Sample Handling and Transportation Errors</b>	Mean	SD	Verbal Interpretation
Number of samples not properly stored before analysis	.002686	.0006440	High Level
Number of samples damaged during transportation	.006000	.0029682	High Level
Number of samples transported at an inappropriate temperature	.002000	.0008775	High Level
Number of samples with excessive transportation time	.001357	.0016328	High Level
<i>Overall</i>	.003014	.0013619	High Level

Furthermore, among the four indicators of sample handling and transportation, the *number of samples damaged during transportation* was the highest (Mean = .006000, SD = .0029685). This is supported by the study conducted by Roque et al. (2015), where it is stated that one of the most common preanalytical errors is due to specimen transportation and delivery. Out of 481 samples collected, four were damaged during transport which can influence the diagnosis. The samples are subjected to deterioration or lesser quality that will compromise the following analytical phase. Factors that may contribute to the damaged samples during transportation include mislabeling the container, wrong fixative, and poor preservation.

This indicates that the private hospitals are susceptible to error associated with the number of samples damaged during transportation among the sample handling and transportation error indicators for having the highest Mean = .006000 and SD = .0029685. However, it is below .05 or 5%, which indicates that the performance level of Private Hospitals is still generally high.

Overall, based on Table 1, the Preanalytical Laboratory Performance Evaluation of Private Hospitals in terms of misidentification errors, test transcription errors, sample collection errors, and sample handling and transportation errors are below .05 or 5%, which indicates that the performance level of Private Hospitals, in general, is high.

**Table 2.1 Preanalytical Laboratory Performance Evaluation of Government-owned Hospitals on *Misidentification Error***

<b>Misidentification Error</b>	Mean	SD	Verbal Interpretation
Number of misidentified samples	.003108	.0021026	High Level
Number of misidentified requests	.001858	.0009501	High Level
Number of samples with fewer than two identifiers	.003683	.0023218	High Level
Number of unlabeled samples	.001125	.0009353	High Level
<i>Overall</i>	.002442	.0014387	High Level

Results revealed that among the four indicators of misidentification errors, respondents from Government hospitals' most frequently committed error was indicator no. 3 which is '*Number of samples with fewer than 2 identifiers*' (Mean = .003683, SD = .0016582). As standardized by the Clinical and Laboratory Standards Institute (CLSI), the process of accurate patient identification requires a minimum of two unique patient identifiers that should be used when collecting samples for clinical testing or when providing other treatments and procedures to prevent diagnostic errors and inappropriate patient management. However, in an observational study conducted by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM) Working Group for Preanalytical Phase (WG-PRE), phlebotomists failed to identify the patient according to CLSI or local guidelines in up to 16% of cases. Data showed that labeling was not carried out in the presence of the patient in nearly one-third of cases, thus leading to rejection rates as high as 0.3% of all samples due to receipt of unlabeled tubes and misidentification error (Mrazek et al., 2020)

This indicates that the Government-owned hospitals are susceptible to error associated with the Number of samples with fewer than two identifiers among the Misidentification error indicators for having the highest Mean = .003683 and SD = .0023218. However, it is below .05 or 5%, which indicates that the performance level of Government-owned hospitals is still generally high.

**Table 2.2 Pre-Analytical Laboratory Performance Evaluation of Government-owned Hospitals on *Test transcription Error***

<b>Test transcription Error</b>	Mean	SD	Verbal Interpretation
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Number of outpatients requests with erroneous data entry (test name)	.004467	.0034974	High Level
Number of outpatients requests with erroneous data entry (missed test)	.001858	.0015198	High Level
Number of outpatients requests with erroneous data entry (added test)	.001850	.0018725	High Level
Number of inpatients requests with erroneous data entry (test name)	.001283	.0011668	High Level
Number of inpatients requests with erroneous data entry (missed test)	.001158	.0016189	High Level
Number of inpatients requests with erroneous data entry (added test)	.001967	.0015785	High Level
<i>Overall</i>	.002100	.0017389	High Level

Among the six indicators of test transcription errors, indicator no. 1, which is 'Number of outpatients requests with erroneous data entry (test name),' was the highest (Mean = .004467, SD = .0034974). This is supported by the study conducted by De Gruyter (2017) wherein he also utilized the same Working Group - Laboratory Errors and Patient Safety (WG-LEPS) standard by the IFCC and found out that amongst the six (6) other indicators, 'Number of outpatients requests with erroneous data entry (test name)' is one of the highest contributors in the test transcription error inside the laboratory being the 2nd highest during the years 2014 and 2015, and the 1st highest during the year 2016.

This indicates that the Government-owned hospitals are susceptible to errors associated with the Number of outpatients requests with erroneous data entry (test name) among the Test transcription error indicators for having the highest Mean = .004467 and SD = .0034974. However, it is below .05 or 5%, which indicates that the performance level of Government-owned hospitals is still generally high.

**Table 2.3 Pre-Analytical Laboratory Performance Evaluation of Government-owned Hospitals on Sample Collection Error**

<b>Sample Collection Error</b>	Mean	SD	Verbal Interpretation
Number of samples of wrong or inappropriate type	.003058	.0019714	High Level
Number of samples collected in the wrong container	.002667	.0012851	High Level

Number of samples with insufficient sample volume	.003142	.0022232	High Level
Number of samples with inappropriate sample-anticoagulant volume ratio	.001083	.0008122	High Level
Number of contaminated samples	.002408	.0019048	High Level
Number of hemolyzed samples	.008867	.0054965	High Level
Number of clotted samples	.005700	.0041158	High Level
<i>Overall</i>	.003858	.0022869	High Level

Likewise, among the seven indicators of sample collection errors, indicator no. 6, which is 'Number of hemolyzed samples,' was the highest (Mean = .008867, SD = .0054965). This is supported by the experiment conducted by Najat (2017) in Sulaimani City, wherein the researcher recorded fifteen (15) types of pre-analytical errors, with hemolyzed samples being the highest number of percentages (9%). Another study conducted by Dikmen et al. (2015) in a government-owned hospital found out that the most commonly reported types of preanalytical errors in the stat laboratory were hemolyzed samples which were 46.4% in biochemistry. Azman et al. (2019) also added that the most prevalent pre-analytical interference and a major source of error producing unreliable laboratory test results is hemolysis of blood samples.

This indicates that the Government-owned hospitals are susceptible to error associated with the Number of hemolyzed samples among the Sample collection error indicators for having the highest Mean = .008867 and SD = .0054965. However, it is below .05 or 5%, which indicates that the performance level of Government-owned hospitals is still generally high.

**Table 2.4 Pre-Analytical Laboratory Performance Evaluation of Government-owned Hospitals on Sample Handling and Transportation Errors**

<b>Sample Handling and Transportation Errors</b>	Mean	SD	Verbal Interpretation
Number of samples not properly stored before analysis	.002342	.0013146	High Level
Number of samples damaged during transportation	.003175	.0018111	High Level

Number of samples transported at an inappropriate temperature	.001583	.0010143	High Level
Number of samples with excessive transportation time	.000692	.0005143	High Level
<i>Overall</i>	.001942	.0010553	High Level

Furthermore, among the four indicators of sample handling and transportation, indicator no. 2, which is '*Number of samples damaged during transportation,*' was the highest (Mean = .003175, SD = .0018111). This is supported by a study conducted by Najat (2017) wherein among 5,550 samples from public diagnostic laboratories, 39% accounts for the samples damaged during transportation, making it one of the most common types of errors that showed an alarming trend and required corrective actions on the selective hospitals to minimize this type of error. Conditions associated with the damaged samples include the various temperature fluctuations that the samples frequently underwent before reaching the laboratory for analysis, including the not properly air-conditioned and ambient temperatures, the unspecialized containers that are essential to keep the viability of certain samples during specific transport conditions, and lack of training of the staffs.

This indicates that the Government-owned hospitals are susceptible to error associated with the Number of samples damaged during transportation among the Sample handling and transportation error indicators for having the highest Mean = .003175 and SD = .0018111. However, it is below .05 or 5%, which indicates that the performance level of Government-owned hospitals is still generally high.

Notably, the Pre-Analytical Laboratory Performance Evaluation of Government-owned Hospitals in terms of misidentification errors, test transcription errors, sample collection errors, and sample handling and transportation errors are below .05 or 5%, which indicates that the performance level of Government-owned Hospitals, in general, is high.

**Table 3 Comparison on the Level of Performance of Private and Government-owned Hospitals Affiliated with the University of Santo Tomas on *Misidentification Errors***

<b>Misidentification Errors</b>	Private		Government-owned		p-value
	N = 7		N = 12		
	Mean	SD	Mean	SD	

Number of misidentified samples	.004829	.0021422	.003108	.0021026	.100
Number of misidentified requests	.002243	.0007390	.001858	.0009501	.384
Number of samples with fewer than 2 identifiers	.005343	.0016582	.003683	.0023218	.120
Number of unlabeled samples	.001014	.0008071	.001125	.0009353	.592
<i>Overall</i>	.003343	.0009396	.002442	.0014387	.142

Table 3 shows the comparison between the Level of Performance of Private and Government-owned Hospitals Affiliated with the University of Santo Tomas on *Misidentification Errors*.

Results revealed that none of the indicators of *misidentification errors* have significant differences as indicated by their p-values, all greater than .05. Although the overall *misidentification errors* of Private Hospitals (Mean = .003343, SD =.0009396) is higher than Government-owned Hospital (Mean = .002442, SD = .0014387), the p-value is .142. This indicates that there is *no significant difference between the levels of performance of the two hospitals in terms of Misidentification Errors*.

**Table 4. Comparison on the Level of Performance of Private and Government-owned Hospitals Affiliated with University of Santo Tomas on *Test transcription Errors***

Test Transcription Errors	Private		Government-owned		p-value
	N = 7		N = 12		
	Mean	SD	Mean	SD	



Number of outpatients requests with erroneous data entry (test name)	.006229	.0023690	.004467	.0034974	.100
Number of outpatients requests with erroneous data entry (missed test)	.001371	.0008616	.001858	.0015198	.773
Number of outpatients requests with erroneous data entry (added test)	.001471	.0010436	.001850	.0018725	.902
Number of inpatients requests with erroneous data entry (test name)	.000771	.0005648	.001283	.0011668	.432
Number of inpatients requests with erroneous data entry (missed test)	.001057	.0008904	.001158	.0016189	.650
Number of inpatients requests with erroneous data entry (added test)	.001786	.0007244	.001967	.0015785	.592
<i>Overall</i>	.002114	.0007290	.002100	.0017389	.536

Table 4 shows the comparison between the Level of Performance of Private and Government-owned Hospitals Affiliated with the University of Santo Tomas on *Test Transcription Errors*.

The results from the Mann-Whitney U Test revealed that none of the indicators under *Test Transcription errors* has significant differences as indicated by their p-values which are all greater than .05 ( $p > 0.05$ ). Although the overall *Test transcription errors* of Private Hospitals (Mean = .002114, SD = .0007290) is higher than Government-owned Hospitals (Mean = .002100, SD = .0017389), the p-value is .536. This indicates that there is *no significant difference between the levels of performance of the two hospitals in terms of Test Transcription Errors*.

**Table 5. Comparison on the Level of Performance of Private and Government-owned Hospitals Affiliated with University of Santo Tomas on *Sample Collection Errors***

Sample Collection Errors	Private		Government-owned		p-value
	N = 7		N = 12		
	Mean	SD	Mean	SD	
Number of samples of wrong or inappropriate type	.005800	.0036647	.003058	.0019714	.028
Number of samples collected in wrong container	.003443	.0008304	.002667	.0012851	.340
Number of samples with insufficient sample volume	.003643	.0011886	.003142	.0022232	.227
Number of samples with inappropriate sample-anticoagulant volume ratio	.001800	.0026026	.001083	.0008122	.902
Number of contaminated samples	.002343	.0008867	.002408	.0019048	.711
Number of hemolyzed samples	.011629	.0034422	.008867	.0054965	.142
Number of clotted samples	.009986	.0081881	.005700	.0041158	.083
<i>Overall</i>	.005500	.0025826	.003858	.0022869	.083

Table 5 presents the comparison between the Level of Performance of Private and Government-owned Hospitals Affiliated with the University of Santo Tomas on *Sample Collection Errors*.

It can be noted that the Mean Percentage of Error of indicator no.1, which is the ‘*Number of samples of wrong or inappropriate type*’ of *Sample Collection Errors* for Private Hospitals (Mean = .005800, SD =.0036647), is higher than Government-owned Hospital (Mean = .003058, SD = .0019714) with the p-value of .028. This implies a significant difference in the number of samples of wrong or inappropriate type between the two hospitals, with the Private hospitals having the higher percentages of error. However, the study done by Chawla et al. (2010) was not inclined with this study because the variable that received the highest frequency rating was specimen hemolysis at 1.10% for inpatients and insufficient volume for testing at 1.2% for outpatients. Another study with different findings is the one conducted by Gimenez-Marín et al. (2014), which found out that the highest rates were found for the indicators “haemolysed sample” (8.76%).

Generally, though the overall *Sample Collection Errors* of Private Hospitals (Mean = .005500, SD =.0025826) is higher than Government-owned Hospital (Mean = .003858, SD = .0022869), the p-value is .083. This indicates that there is no significant difference between the levels of performance of the two hospitals in terms of *Sample Collection Errors*. This is supported by Gubaton et al. (2020), wherein they found out that private hospitals had a higher mean in the sample collection. Still, the overall data have no significant difference against government-owned hospitals, having only a p-value of less than 1% ( $p < 0.001$ ). According to Plebani et al. (2011), the lack of standardized procedures for sample collection, including patient preparation, acquisition of specimens, and handling or storage, accounts for up to 93% of the errors encountered in the diagnostic process within the laboratory. However, the study conducted by Abdollahi et al. (2014) is not inclined with this study because they have found out that sample collection errors showed great significance in relation to laboratory performance of the hospitals, garnering a total of 20.89% (4685) of pre-analytical errors for outpatient and 28.19% (21,789) for inpatient.

**Table 6. Comparison on the Level of Performance of Private and Government-owned Hospitals Affiliated with the University of Santo Tomas on *Sample Handling and Transportation Errors***

Sample Handling and Transportation Errors	Private		Government-owned		p-value
	N = 7		N = 12		
	Mean	SD	Mean	SD	

Number of samples not properly stored before analysis	.002686	.0006440	.002342	.0013146	.650
Number of samples damaged during transportation	.006000	.0029682	.003175	.0018111	.010
Number of samples transported at inappropriate temperature	.002000	.0008775	.001583	.0010143	.261
Number of samples with excessive transportation time	.001357	.0016328	.000692	.0005143	.711
<i>Overall</i>	.003014	.0013619	.001942	.0010553	.068

Table 6 shows the comparison between the Level of Performance of Private and Government-owned Hospitals Affiliated with the University of Santo Tomas on *Sample Handling and Transportation Errors*.

Notably, the Mean Percentage of Error of indicator “*Number of samples damaged during transportation*” from the factor *Sample Handling and Transportation Errors* for Private Hospitals (Mean = .006000, SD = .0029682) is higher than Government-owned Hospital (Mean = .003175, SD = .0018111) with the p-value of .010. This implies that there is a significant difference in the damaged samples received between Private and Government-owned hospitals.

Overall, for the *Sample Handling and Transportation Errors*, it is demonstrated in the results that the Private Hospitals (Mean = .005500, SD = .0025826) is higher than Government-owned Hospital (Mean = .003858, SD = .0022869), with the p-value is .068, which indicates that there is no significant difference between the level of performance of the two hospitals in terms of *Sample Handling and Transportation Errors*.

**Table 7. Overall values of each IFCC WG-LEPS Indicators**

	Private	Government-owned	p-value
<b>IFCC Indicator</b>	N = 7	N = 12	

	Mean	SD	Mean	SD	
Misidentification Error	.003343	.0009396	.002442	.0014387	.142
Test transcription Error	.002114	.0007290	.002100	.0017389	.536
Sample Collection Error	.005500	.0025826	.003858	.0022869	.083
Sample Handling and Transportation Errors	.003014	.0013619	.001942	.0010553	.068

Table 7 shows the values for each IFCC WG-LEPS indicator for both Private and Government-owned Hospitals Affiliated with the University of Santo Tomas.

Notably, the indicator for “*Sample Handling and Transportation Errors*” with a p-value of .068 contains the highest p-value among the four pre-analytical phase quality indicators. It is followed by “*Sample Collection Error*” with a p-value of .083, “*Misidentification Error*” with a p-value of .142, and least is the “*Test transcription Error*” with the lowest p-value of .536. This indicates that the “*Sample Handling and Transportation Errors*” is the quality indicator that contributes the most to the difference between the Laboratory Performance of Private and Government-owned Hospitals.

This is supported by a study conducted by Gubaton et al. (2020); the variable “*Sample handling and Transportation*” as one of the common errors in the pre-analytical phase, has shown accuracy, precision, and reliability in the performance of the laboratories and are of great help in assessing and comparing results between the Government-owned and Private hospitals and was classified under Quality indicator Priority “1”. In a study conducted by Najut (2017), it was found out that out of 10 different hospitals included in his study, it was “*Delay in sample transportation*” that contributed the most (35-40% of pre-analytical error), and also a high prevalence of sample not being stored properly / “*sample not on ice*” (15-20%) both of which are factors under *Sample Handling and Transportation Errors*. Felder (2011) added that sample quality could be compromised by exposure to extremes of temperature and physical forces during transportation which mainly contributes to the errors during the pre-analytical phase of laboratory testing. Lastly, a study by Mrazek (2017) done on European laboratories reported proportions of unsuitable samples due to inappropriate time and temperature conditions during sample transportation can be as high as 3.4% and 1.2% of all samples received, respectively and 1.9% in relation to the errors analyzed.

However, the study done by Mrazek, C. (2020) was not inclined with this result because he instead found out that it was the sample collection error (which accounts for about 40% of all errors) is the one with that contributed the most to the errors between the hospitals included in his study which is then followed by Misidentification error (accounts for about 30% of all errors), Test transcription error (accounts for about 20% of all errors), Sample handling and transportation (accounts for about 10% of all errors).

## **METHODOLOGY**

### **Research Design**

A descriptive-comparative research design had been employed in this study. The research had utilized quantitative data collection through the use of a structured questionnaire that had been employed online as a one-time survey only through the use of email (google forms) as the data collection platform for organized data gathering to evaluate the pre-analytical laboratory performance of private and government-owned hospitals affiliated to University of Santo Tomas based on quality indicators provided by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC). The quantitative survey form had been divided into four categories, corresponding to the possible errors encountered in the preanalytical phase of laboratory testing. This includes the misidentification errors, test transcription, sample collection, and sample handling and transportation errors. Through the use of these indicators, the level of pre-analytical laboratory performance of the private and government-owned hospitals affiliated to University of Santo Tomas had been determined and compared with each other.

### **Research Locale**

The locale for this research is within Metro Manila and in Bulacan, Philippines for the researchers to have ease of access to the different private and government-owned hospitals for data gathering with regards to their laboratory performance with the use of Quality Indicators (QI). There are a total of 20 established hospitals within Metro Manila and 1 from Bulacan, 8 hospitals that are privately-owned and 13 government-owned hospitals affiliated to University of Santo Tomas.

### **Sampling Procedure**

The researchers created a quantitative survey (answered numerically) based on the standards made by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) that was submitted and approved by the Ethics Board Committee of the University of Santo Tomas. After the approval, revisions are made to improve the survey questionnaire and be comprehensive. Consequently, the researchers disseminated the survey through purposive sampling technique with a questionnaire through email (google forms) to the clinical laboratory's section supervisors, chief medical technologist, or medical technologist of the chosen hospitals.

### **Data Collection**

The researchers distributed the questionnaires online through the use of email (google forms) as the data collection platform for organized data gathering. The researchers included

in the form the reason for collecting the data and assure that all information to be gathered are strictly confidential and are solely used for the research study only. A total of 21 survey questionnaires were sent, however only 19 University of Santo Tomas (UST) affiliated hospitals agreed to answer the questionnaire, eight (8) from privately-owned and eleven (11) from government-owned hospitals. The responses gathered are then arranged and tallied.

### Data Analysis

The Preanalytical laboratory performance had been evaluated through the tabulation of the gathered and tallied data from the instrument and by using the following statistical tools:

**Frequency.** This has been used to determine the number of times errors occurred in each quality indicator of the preanalytical testing phase.

**Formula:**

$$f = n$$

**Where:**  $f$  = frequency

$n$  = number of times the data value occurs per quality indicator

**Percentage.** This has been used to determine the proportion of the number of errors in each quality indicator of the preanalytical testing phase in relation to the total number of samples received in each private and government-owned hospital.

**Formula:**

$$\% = \frac{f}{N} \times 100$$

**Where:** % = percentage

$f$  = frequency

$N$  = total number of sample/request received

**Percentile.** This statistical tool has been used to compare a particular percentage score of a certain indicator of one hospital to the percentage scores of a certain indicator from the rest of the hospitals.

**Formula:**

$$P = \left( \frac{n}{N} \right) \times 100$$

**Where:**  $P$  = percentile

$n$  = ordinal rank of a given value

$N$  = number of values in a data set

**Verbal Interpretation.** Based on the criterion set by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC), the verbal interpretation had been set as follows:

25th percentile value - High level of performance

50th percentile value - Medium level of performance

75th percentile value - Low level of performance



**Mann-Whitney U Test.** This has been used to determine the significant difference in the quality indicators between private and government-owned hospitals affiliated with the University of Santo Tomas.

**Formula:**

$$U_1 = n_1 n_2 + \frac{R_1(R_1+1)}{2} - R_1$$

$$U_2 = n_1 n_2 + \frac{R_2(R_2+1)}{2} - R_2$$

**Where:** R = sum of ranks in the sample  
n = number of items in the sample

## CONCLUSION

The Pre-Analytical Laboratory Performance Evaluation of Private Hospitals and Government-owned Hospitals Affiliated to University of Santo Tomas for the 4 indicators (misidentification errors, test transcription errors, sample collection errors, and sample handling and transportation errors) are all of High Level. The study found out that there is no significant difference between the Laboratory Performance of Private and Government-owned Hospitals Affiliated to University of Santo Tomas in terms of the 4 indicators used (misidentification errors, test transcription errors, sample collection errors, and sample handling and transportation errors). Furthermore, among the 4 pre-analytical phase quality indicators (misidentification errors, test transcription errors, sample collection errors, and sample handling and transportation errors), the sample handling and transportation errors has the most significant effect ( $p = 0.068$ ) in the difference between the Laboratory Performance of Private and Government-owned Hospitals Affiliated to University of Santo Tomas.

The accuracy, precision, and quality of pre-analytical laboratory performance of both the private and government-owned hospitals could be measured and evaluated through a set of indicators/parameters. The performance level of both Private and Government-owned hospitals affiliated with the University of Santo Tomas was compared using the same parameters (misidentification errors, test transcription errors, sample collection errors, and sample handling and transportation errors) as a reference. To sum it up, both Private and Government-owned Hospitals affiliated with the University of Santo Tomas demonstrated High-Level Performance, even at this time of the pandemic, backed by the data collected in this study. Pre-analytical errors done by these hospitals were kept at a minimum which shows that quality is still monitored in their respective laboratories. The hospitals have very little differences in preanalytical errors but show no significance, though study limitations can be part of. Therefore, the level of performance shown by these hospitals suggests that the quality of their service and the kind of healthcare they are offering is still of the highest quality. With the researchers' findings, it may be inferred that there is quality in the total testing process of the hospitals affiliated with the University of Santo Tomas. Quality control and quality assurance may be frequently monitored as their performance for the pre-analytical phase are of high level. Additionally, delivering quality patient care starts with the pre-analytical phase, which is the reason why this step is critical and must be thoroughly monitored.

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The researchers did not have a conflict of interest in any form (personal, financial, proprietary, or professional) with the sponsor/grant-giving organization, the study, the co-investigators/personnel, or the site. The researchers certify that they had abided by the ethical principles in this document. The researchers had submitted a final report of the proposed study to the UST Faculty of Pharmacy Research Ethics Office. They did not commence with data collection until they received an ethics review approval from the FOP Research Ethics Committee.

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## Proper Optimization Strategy for Donated Medical Devices in Yemeni Governmental Medical Sectors

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**Abstract**— It is commonly stated that the majority of donated medical equipment in underdeveloped countries like Yemen is dysfunctional due to bad medical device management strategies, with estimates ranging as high as 80% out of service. However, there is little written evidence to substantiate these claims. Many literature reviews were collected to prove this issue in low- and middle-income countries that have mismanagement of donated devices, due to poor infrastructure, shortage of spare parts, lack of proper maintenance training, and lack of E-Government platform. The aim of this study is to determine the quantity of donated medical equipment that is no longer in use in Yemeni government hospitals and identify possible causes. The researcher uses a structured interview method with the person who uses these devices in the hospitals like biomedical engineers, maintenance engineers, technicians, and inventory managers to significantly address the issue of having donated devices out of service and what may be the best practice solution to get them back to service. This information will be then analyzed and proper recommendations will be introduced to the Ministry of Health and Housing to guide governmental hospitals to the proper optimization of the donated medical equipment.

**Keywords**—Donations \_ Technology \_ Strategy \_ Decision making \_ Medical equipment \_ Health sectors \_ E-Government

## **I. INTRODUCTION**

Along with global health inequities, many low- and middle-income countries face shortages of essential medical devices and medical supplies. External governments or non-governmental organizations (NGOs) make grants to countries or individual health facilities to address these inequalities. The delivery of modern health care, including health-care devices, is highly reliant on technology. Many underdeveloped countries like Yemen health sectors are forced to rely heavily on equipment donations due to financial constraints. Nearly 80% of health-care equipment is donated or provided by international donors or foreign governments in certain countries (Dyro, 2004). While most donations are made with good intentions, if they are not well organized and arranged, the results are not always positive.

The implementation, use, and maintenance of health-care equipment necessitate substantial financial, operational, and human capital. Regrettably, this is not always completely appreciated. According to WHO (WHO, 2000) only 20% of donated equipment is operational in developing countries. Mismanagement in the technology procurement process, a lack of user training, and inadequate technical support are all explanations for unused equipment. When performed correctly, medical device donation initiatives have the ability to increase healthcare access in some of the world's poorest areas. However, poorly implemented donations can cause damage and stress recipient countries.

Medical equipment is widely used in the diagnosis and care of patients. In today's world, providing health services through the use of diagnostic and treatment devices is a critical component of health care, especially in hospitals (Wang, 2008). Medical devices are assets that directly improve the quality of life for many people (Painter, 2011). Clinical engineers are in charge of medical devices that include calibration, servicing, repair, user training, and decommissioning.

Depending on a field site visit conducted it is found that many of the donated medical device in more than five main governmental health care facilities in Sana'a, Yemen was out of service or broken, and due to this the medical device is thrown in bad conditioned and ignored hospital store environment.

This study best practices and considerations are intended to enhance the efficiency of donated medical equipment use and identify the constrains faced by healthcare facilities regarding spear parts, consumables, and training of proper medical device use in the first place, then providing maintenance to out of service. This can provide recommendations on the proper optimization of donated medical device in Yemeni medical sectors and to the Ministry of Health and Housing.

These factors may be used to establish medical equipment donation policies and regulations at the institutional and national levels. These considerations can be applied anywhere, but they may be particularly useful for health systems in developing countries that rely heavily on donations. While this study focuses on medical equipment, many of the considerations relate to other forms of donations as well, such as medical supplies and consumables.

## **II. FACTORS INFLUENCING THE PROPER OPTIMIZATION OF DONATED MEDICAL DEVICES IN UNDERDEVELOPED COUNTRIES MEDICAL SECTORS.**

As it is collected from the literature reviews of this issue the study can identify an internal and external factor for the best optimization of donated medical devices, thus the study can explain them as follows:

### *A. Internal Factors*

All underdeveloped countries medical facilities have problems with the donated device, starting with their infrastructure, these hospitals are not prepared well to maintain those donated device, and by this the study can define several criteria:

#### *1) Power Source Stabilities and Reliability.*

Although health-care technologies have improved steadily in developed countries, developing countries have yet to reap the full benefits of this progress. Many electric medical devices fail due to a variety of factors, including unreliable power sources, inappropriate technologies, and a lack of maintenance (Adair-Rohani, 2013). Normal blackouts, in particular, result in repeated unavailability of medical equipment and health facilities, whereas electrical surges and transients can destroy several devices. According to a vast study based on data collected from 33 hospitals in 10 developing countries (Malkin R. , 2007), “The most common single cause of failure was the power supply (29.9%)” on a total of 975 pieces of damaged equipment. As a result, a safe and sustainable energy supply is part of the global slogan "Health for Everyone in the Third Millennium."

Despite this, most programs aimed at improving hospital infrastructure in developed countries have concentrated on medical equipment or providing certain electricity generation systems for those who are not linked to the national electricity grid. In a similar vein, the majority of the few research on electricity supply in Sub-Saharan hospitals concentrate on the number of hours with access to energy rather than the efficiency and reliability of the electricity. This is a challenge because power outages affect the long-term viability and efficiency of medical care, as well as a population's health and well-being. This, in turn, has an indirect effect on school attendance (and therefore education level), as well as the national economy, since working population ability is reduced (Ngounou, 2014 ).

#### *2) Medical device occupying environment.*

Understanding the differences between cleaning, disinfection, and sterilization is critical when determining the amount of decontamination necessary for a certain medical equipment.

Cleaning, the elimination of bodily materials, dust, or alien matter by physical means. Cleaning reduces the quantity of microorganisms and soil on the surface being disinfected or sterilized, allowing for better contact and minimizing the danger of soil adhering to the surface. The chance of a chemical disinfectant becoming inactive and germs multiplying is also reduced when dirt is removed. Contamination is removed from an object to the amount required for continued processing or intended usage (PAHO, 2016).

Disinfection, microorganisms are destroyed or removed at a level that is not damaging to health and is easy to handle. The elimination of bacterial spores is not always part of this process. Sterilization, The complete destruction or removal of microorganisms, including bacterial spores. Sterility state of being free from viable microorganisms. Sterilization validated process used to render a product free from viable microorganisms (PAHO, 2016).

#### *3) Hospital Medical Equipment Maintenance Management.*

Medical equipment management specialists ensure that the equipment used in patients' care is operational, safe, and properly configured to meet the medical treatment facility's mission, as well as that it continues to function effectively and in good working order. Proper maintenance, for example, can extend the life of equipment. This is critical for providing high-quality health care while conserving limited resources. Medical equipment management, on the other hand, encompasses a wide range of operations that guarantee that equipment is properly planned, budgeted, acquired, and operated, among other things (Usdin M, 2006).



Hospitals employ human factors engineering to impact maintenance and medical equipment purchase choices. The procedure guarantees the acquisition of the safest, most efficient, and effective maintenance instruments and gadgets. When used to the design and assessment of medical devices, human factors engineering is commonly highlighted as a significant strategy for reducing medical error and adverse occurrences while also increasing patient safety (Usdin M, 2006).

### *B. External Factors.*

When talking in the external factor the study concentrate in the donor part of the problem, when accruing a donation the donor should at least know that this countries are poor enough to provide a training service for the device in the part of installation of medical device or maintenance, let alone providing spare parts for such advanced device, the study can summarize those factors to be:

#### *1) Spare Parts*

The shortage of spare parts in the underdeveloped countries is the most significant design hurdle. Any computer intended for use in developed countries is likely to fail as soon as the first repair component is required. If a filter has to be changed every six months, for example, the unit would most likely only last six months in a developing-world hospital. This may be due to a lack of replacement parts in the developed world, the fact that the parts are no longer manufactured, or the fact that the item requires the use of a credit card to buy (few people in the developing world own a credit card) (Malkin R. , 2007).

Recent research shows (Malkin R. , 2007), however, that the shortage of replacement parts is overly frequently cited as a concern. Just 12.3% (120 out of 975) of the damaged pieces of equipment reported by participants in the Engineering World Health (EWH) study needed a replacement component that could not be produced or assembled in the developed world. As a result, the scarcity of spare parts can be a minor issue compared to what is commonly assumed. There are other reasons why pieces struggle to be replaced. The cost may be prohibitive, or the hospital may lack the necessary expertise or equipment. A technician with more than a high school diploma is rare in most hospitals.

The hospital may believe that the spending is a waste of money in some situations. According to a EWH survey, a hospital found it cheaper to order a new oxygen concentrator from their European sponsor than to pay the \$5 needed to replace the concentrator they already had (Malkin R. , 2007). Another problem with electronic components in developed countries is a shortage of technical personnel who are inspired. Staff anger was cited by several participants in the EWH sample as a factor in their inaction (Malkin R. , 2007). Frustration may be caused by a shortage of resources and manuals, as well as political corruption, which can spread to public hospitals or organized biomedical engineering facilities. Because of their dissatisfaction, technicians may decide not to attempt a repair or maintenance operation.

#### *2) Consumables*

The shortage of consumables is one of the most common issues in developing-world hospitals. Consumables are materials or components that are used for the use of the machinery but can only be reused once or twice (e.g., test strips, ECG electrodes, blood pressure transducers or electro-surgery tips). Most of the time, the item is clearly unavailable in the world (Malkin R. A., 2007).

Specific consumables cannot always be avoided, and common consumables must be packed in specialized packages in certain instances. The packages or specifications, on the other hand, are often introduced as part of an economic model (the color printer is inexpensive, but the toner cartridges are expensive). One of the most common obstacles to the purchasing

of medical supplies by developed world hospitals or donating organizations is the failure to provide replacement consumables.

### *3) Inventory Management*

Health-care technology has become a vital component of care because it allows physicians to diagnose, treat, track, and provide counseling to patients in a safe and effective environment. Health-care infrastructure quality control ensures that these programs are delivered in a secure and efficient manner. The first step in health-care technology management is to figure out what needs to be managed and build a health-care technology inventory.

The inventory is a living document that is reviewed and updated on a regular basis to ensure that the state of healthcare technology assets is accurately reflected. When used correctly, the inventory can be a valuable and effective method for bettering the management of many critical aspects of health-care technology (WHO, 2011).

A medical equipment inventory can aid in the identification of spare parts and consumables needed to keep the machine working. Inventory of spare parts and consumables alerts the team to purchase stock so that existing reserves aren't exhausted and service isn't interrupted. The primary goals are to calculate consumption rates (number of parts per unit of time) and to set a reorder standard that is adequate to sustain operation over the time it takes to order and receive new parts. Item stock quantities are never exhausted when properly handled, and operation is never disrupted (WHO, 2012).

Any health-care facility should evaluate its needs so that it can act effectively to deliver the services and procedures that are specified within the facility's framework. This assessment also requires the forms and amounts of equipment used to successfully carry out these treatments. This list will also be applied to the actual inventory to locate equipment inventory shortages and surpluses, as well as plan how to better fulfill the organization's needs. Inventory shortages may be quantitative (not enough computers to satisfy patient demand) or relational (not enough machines to meet patient demand) (relating to performance, integrity, reliability and functionality of the equipment). This needs evaluation will be used to prepare for new equipment purchases or to compile donor "wish lists" to collect appropriate donations (WHO, 2012).

A piece of equipment has a set lifespan and may need to be replaced or discarded at some point. When equipment is no longer serviceable, appropriate, reliable, or cost-effective, over history associated with inventory items may be evaluated. Trends over time can assist in determining the projected lifespan of equipment as well as the cost-effectiveness (or lack thereof) of keeping a piece of equipment in operation. This data will be used to create strategies for equipment replacement and disposal. This knowledge will then be used to create estimates for new capital investments, maintenance programs, and other expenses (Kaur, 2005).

When equipment has to be removed or disposed of, it is usually purchased or donated. The health-care facility will classify equipment that it requires to purchase by tracking inventory levels and patterns over time and conducting a needs review of appropriate technology. This data will be used to create a buying strategy, defining essential equipment that must be acquired immediately and setting procurement targets for the future. If infrastructure is found to be missing, it will be attached to a donor wish list, which can then be sent to charitable organizations to promote valuable and appropriate donations (Kaur, 2005).

### **III. METHODOLOGY**

The study architecture, population and sampling methods used, instrumentation, data processing, the scale of validity and reliability, as well as the data analysis process will be furthermore explained here. The data collection was done in a structured manner, and the study was done using the Statistical Package for the Social Sciences (SPSS) software for an appropriate analysis of the data collected.

### *A. Research Design*

A research design is a strategy for gathering data, measuring it, and analyzing it in order to address the research question (Sekaran & &, 2016). This study uses a structured interviews design. Structured interviews are those in which the information required is identified from the start.

The analyst takes notes as the respondents share their opinions. All will be asking the same questions in the same way. However, depending on the circumstances, an experienced researcher might take a cue from a respondent's response and ask additional pertinent questions not included in the interview procedure.

### *B. Population and Sampling*

The population in this study is the all personnel that works with donated medical devices in Yemeni governmental hospitals, these personnel are Hospital Managers, Biomedical Engineering Divisions, Maintenance Divisions, Doctors, Local clinical heads, Devices Operators, Technicians, Inventory Divisions. Number of 20 governmental hospital were covered in different rural an urban Yemeni province.

The researcher chose the personnel that deals with the donated medical equipment in order to collect their perspectives in dealing with the equipment and know what are the main reasons, based on each part perspectives, that make the donated equipment out of service. In addition, the researcher understands the main difficulties and issues that the personnel face when using the donated devices, the population was chosen in order to investigate the effect of the factors that influence the proper optimization of donated medical devices.

Purposive judgmental sampling was used to select the sample frame, since it is limited to certain persons who can provide the sought-after material, the sampling is purposive. Since they are the only ones who meet the researcher's standards, such entities are the only ones who provide this knowledge or can have the desired information.

### *C. Data Collections*

A structured interview is a dialogue in which an interviewer poses a list of questions to an interviewee in a predetermined order. The interviewee gathers the candidate's answers and grades them using a ranking scale. Interviewers may gather related categories of information conveyed in a uniform context by asking the same questions in the same order.

### *D. Scale of Validity and Reliability*

The use of better instruments ensures the precision of test findings, which contributes to an improvement in the research's analytical efficiency. The researcher wanted to make sure that the instruments used in the study correctly measured what they were designed for. As a result, a validity and durability evaluation was conducted, people with different background in donated device from WHO, governmental hospital, expert biomedical engineers along with technician and maintenance staff were asked to judge on the interview questions. All their response and modifications of the questions were took in to consideration before it was used for the interview.

## **IV. RESULTS AND DISCUSSION**

The results of the interview were collected and introduced into SPSS, a strong statistical analysis and data management application. Each of the six parameters had histograms created for it.

- Power source stabilities and reliability.
- Medical device occupying environment.
- Hospital Medical Equipment Maintenance Management.
- Spare parts.
- Consumables.

- Inventory management.

### *1. Power Source Stabilities and Reliability*

While health technology has improved steadily in developed nations, underdeveloped countries have been unable to fully benefit from this advancement, owing in part to unreliable power sources. Grid failures are responsible for one-third of medical device failures, according to a World Health Organization study. As a result, the global slogan "Health for All in the Third Millennium" necessitates a stable and long-term supply of electricity in hospitals.

The combined percentages mean ratings for generator, central power supply source were 90, 10 percent respectively, these indicates that most Yemeni hospitals are depending on generators for their power supply, here it is important to consider problems associated with power generators when it comes to medical equipment failure due to the instable power supply generated.

It is well known that power generators are supposed to be as a backup solution for the central power supply in all hospitals, but in Yemeni hospitals and due to the war case that Yemeni is facing since 2014, the central power supply is off in many provinces, add to this the bad recourse of the fuel used in this generator that make it cut service many times per month, as it was seen from the results of "How often have power outages happened in the last month?", the combined The combined percentages mean ratings for power cutoff of 1-3 times per month, 4-6 times per month, 7-10 times per month and more than 10 times per month was 9.7, 45.2, 32.3, 1.9 percent respectively, this can show that the greater percentage was for 4-6 times per month which for a healthcare device this is critical, power generators are reliable when it comes in a country like Yemen that suffers from fuel supply shortage.

### *2. Medical Device Occupying Environment.*

Cleaning refers to the removal of visible dirt, dust, and debris in a healthcare setting. Cleaning alone reduces environmental pollution significantly, including the eradication of numerous diseases.

When it comes to Yemeni medical sectors environment it is shown that it is full of dust due to unreliable cleaning frequency per week in the sector, taking into consideration the insulation or distance from dust the results showed that only 30% of the response where stating that it is good, and the rest 70% where between poor and accepted which in medical sectors this is not acceptable at all, medical device are very sensitive to any dust particles and the environment should always be kept clean.

Other factor to consider in the medical device environment is the ventilation and air flow in the room, since these devices are sensitive to temperature change and they have a high rate of heat when on service, the results were 50% for accepted, 30% to be poor, 10% very poor, and only 20% response were good, medical device should be occupied in a good ventilated environment to prevent breakdown or mistakes in diagnose from this medical due to sensitivity to heat change.

### *3. Hospital Medical Equipment Maintenance Management.*

Maintenance management necessitates close oversight by healthcare managers who may lack the technical knowledge necessary to comprehend all pertinent issues. Since medical devices are affected every medical sector should have a center of training program for medical equipment usage and maintenance. This training program must cover all inspection procedures, preventive maintenance procedures, and corrective maintenance procedures for the donated medical devices, when this was measured the results showed that 80.6% of the response were that the medical sector do not provide training program for medical equipment, where training on

donated medical device is heavily of 83.3% depending on the donor party, and this training only offered technical training regarding the installation of donated medical device only, none of the inspection, corrective or preventive maintenance were given.

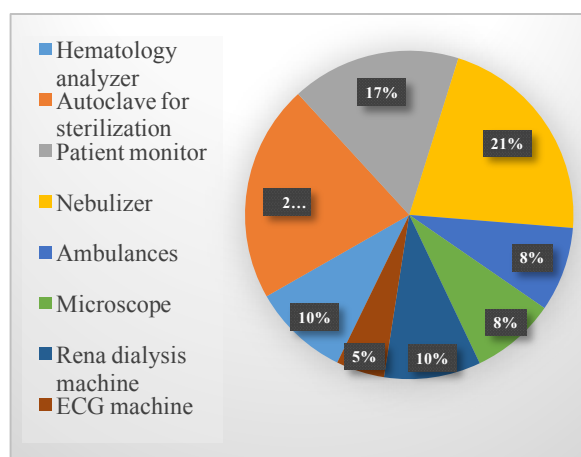


Figure 1: Frequency of recently donated medical equipment in in Yemeni Governmental Medical Sectors

#### 4. Spare Parts.

The most major design challenge in developing nations is a lack of replacement components. Any computer designed for usage in developed countries is almost certain to fail as soon as the first repair component is needed. The study result regarding the shortage of the spare part is the highest, it is found that a high percentage as 92% of why donated medical devices are out of service is because they couldn't find its spare part easily locally, and if they are going to order for it is way expensive for the hospital.

The following table chart shows the donated medical device that are out of service waiting for spare part maintenance process:

Table 1: Out of Service Donated Medical Devices due to Shortage of Spare Parts

	FREQUENCY	VALID PERCENT	CUMULATIVE PERCENT
AUTOMATED ELISA	2	2.1	2.1
ANESTHETICS MACHINE	5	5.2	7.2
HEMATOLOGY ANALYZER	3	3.1	10.3
OXYGEN CONCENTRATOR	2	2.1	12.4
CLINICAL CHEMISTRY ANALYZER	3	3.1	15.5
VENTILATOR	6	6.2	21.6
AUTOCLAVE FOR STERILIZATION	16	16.5	38.1

NEONATAL INCUBATOR	5	5.2	43.3
PATIENT MONITOR	12	12.4	55.7
MICROSCOPE	11	11.3	67.0
NEBULIZER	12	12.4	79.4
AMBULANCES	7	7.2	86.6
RENA DIALYSIS MACHINE	8	8.2	94.8
ECG MACHINE	5	5.2	100.0
TOTAL	97	100.0	

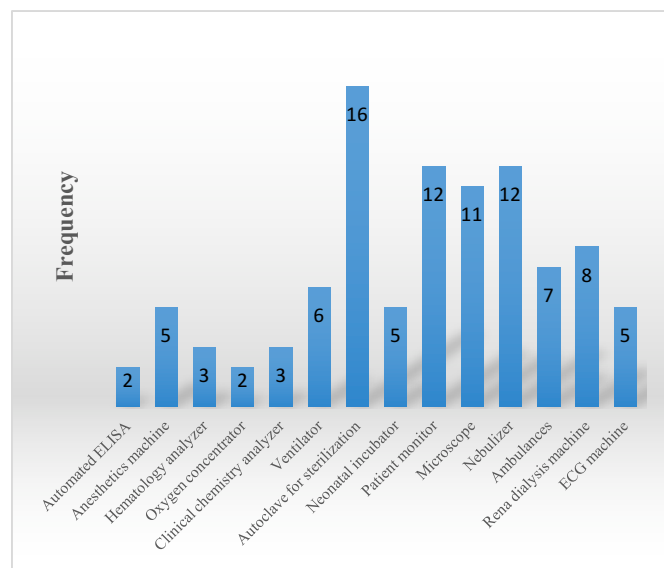


Figure 2: Chart View of Table

### 5. Consumables.

Syringes, needles, sutures, staples, packing, tubing, catheters, medical gloves, gowns, masks, adhesives and sealants for wound dressing, and a whole host of other devices and instruments needed in a hospital or surgical environment are all examples of medical consumables and equipment.

These tools are very important for some medical devices like ECG and others, sometimes the device is said of no use is these consumables are not present. There is a huge shortage when it comes to the local market consumables provider, the study results as shown is found:

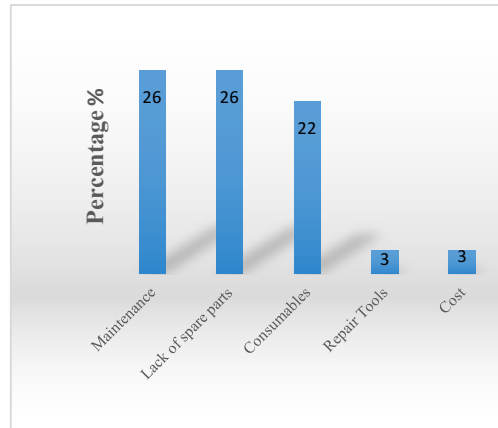


Figure 3: Difficulties in Getting Repairs to Equipment

### 6. Inventory Management.

Inventory management is very important when it comes to healthcare sector, it gives detailed information about the medical device in use, and it can be used as indication to any failure of the medical equipment. All Yemeni medical sectors use computers to save the data base, the quality of using this data base and updating it is found to be 62.1% to be acceptable, 27.6% to be good, and 10.3% to be very good.

These results are as expected but it is not always easy for the donors to have access to because of the lack to E- Government platform regarding the medical devices in all governmental sectors, since this information can help reducing errors when it come to the standard followed by donors in the time of the donation process.

## V. RECOMMENDATIONS AND CONCLUSION

Medical equipment management, which encompasses selection, purchasing, installation, and maintenance, is critical for assuring service readiness and having a positive influence on health care safety and efficacy. It extends the equipment's life and offers vital information for equipment management. The results of the data collection indicated that Yemeni governmental medical sectors did not have effective medical equipment management.

In order to enhance this management several reconditions are proposed regarding all the aspects that has to do with the improvement of the proper optimization of donated medical devices.

Regarding the power source, the medical sectors are recommended to rely on central power source and put generators in the state of backup, nowadays in Yemen we have commercial power source with the same effectiveness of the old before war state central power source, and this can solve a lot of cutoff and non-stabilized electrical source problems, saving the medical equipment from breaking out.

For the facility environment and cleaning, it is always recommended to add the times of cleaning with more disinfection materials for insuring a safe and clean environment. Moreover, it is useful to use negative pressure airflow source in the entrance of the sectors to prevent dust and dirt from entering this facility, by which keeping equipment clean and increase the lifetime service of it.

Serious review on hospital medical equipment maintenance management is needed, it is not recommended that the facility only rely on the donor training of medical device, since the training provided from the donor is only on how to install the device and prepare it to work, all aspects of maintenance like inspection, corrective and preventive maintenance should be considered to insure the proper work of the devices.



Furthermore, the facility is recommended to establish a maintenance center and fully prepare it to cover all kind of training from tools, trainers, and use it to have partnership training with the donor, not to forget that donor must be asked to provide service manual in order for the biomedical engineers to be able to fix the device in case of braking dawn.

When it comes to spare part, the facilities are recommended to prepare a list of spare parts for any device that is will be donated to them, the facility must use the data base it has to properly know what spare parts are needed, not only for the device that will be donated but also for the broken one they have in the inventory.

In case of a sudden failure of the device, the facility is recommended to have a list of local suppliers that have spare parts for the same edition devices like the donated one, if not thy should address this issue to the Ministry of Health and provide a detailed list of the spare parts needed, and the Ministry will add it to the list of medical equipment needed to the donor organizations like WHO and they will be more than welcome to provide the spare part, for this will lead to the improvement of all governmental facilities which is one of the most priority aim of this organizations to fulfil.

Same goes for the consumable part, it is recommended to be in advance prepared with the donation, since some consumables are essential for the device to operate well. Local suppliers can help hereto, the facility is highly recommended to inform the suppliers of the device donated type and provide the serial number of all donated device in order for the suppliers to have the consumables ready in their stock for future need of the facility.

Governmental hospitals along with Ministry of Health and Housing are recommended to have a E- Government plat form regarding all medical devices, donors should have access to the database regarding the consumables status in the hospital.

The last recommendation is regarding the inventory database management, the facility is recommended to always update this database with all aspects and issues of medical device, not only this, but also establish with the help of the Ministry of Health an online plat form of data base that all donors can access and review in order to have a good management when it comes into the decision making of donation procedures.

For the future work that can be done to this research, the slandered followed by the Ministry of Health should be reviewed and well prepared, for this can help overcoming many issues regarding the donation of the medical devices and their proper optimization in all governmental Yemeni sectors.

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# **Urban Public Health: Future Challenges and Plans**

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## **ABSTRACT**

The modern era has changed the lifestyle of humans to affect public health. Health facilities are increasingly improving themselves, but the level of public health, especially in urban environments, is decreasing due to many factors. Many rural people who decide to move to urban areas think that they can change the destiny of life, but without a proper plan it can cause life to remain at a low level with a reflection of living in urban suburbs. Developing countries to date have experienced significant increases in urban population. And there is much that must be improved by the state in order to make its population and territory comfortable to live in.

In this paper, I will explore the challenges and plans in the future related to urban public health, especially in Southeast Asia.

**KEYWORDS:** health, modern, public health, urban

## **1 INTRODUCTION**

In the 21st century most of the world's people have lived in urban areas. Predicted growth in developing countries in urban areas. Complete information and facilities are the main reasons for residents to live in urban areas. Places of education, health, recreation, restaurants, and public places that are provided free of charge are in urban areas. Many residents of developing countries, especially in Southeast Asia, choose to move and settle in urban areas. Due to various figures for urban areas, many villages have responded to the population.

## **2 URBAN PUBLIC HEALTH**

With more than half of the world's human population now living in cities, and with a proportion that is projected to increase in the future, cities are a benchmark for a country's development from the welfare of the population, the level of education, the level of the economy, to the level of health. Overall, urban areas are more developed than rural areas, this can be proven by the increasing number of rural residents moving to urban areas. There are many positive aspects seen from the infrastructure of urban life, such as the ease of getting a job, higher income, better opportunities for education, and access to health care, which are the background for the higher progress of urban people than rural communities.

I am a citizen who was born, raised, and lives in rural areas. In rural Asia there is minimal in many areas, especially health. There is no big hospital built in the village, only a small health clinic with minimal facilities which until now is a reality in the health sector in Southeast Asia. Several things that need to be considered by the government must be to develop facilities in the village, especially health facilities needed by all people.

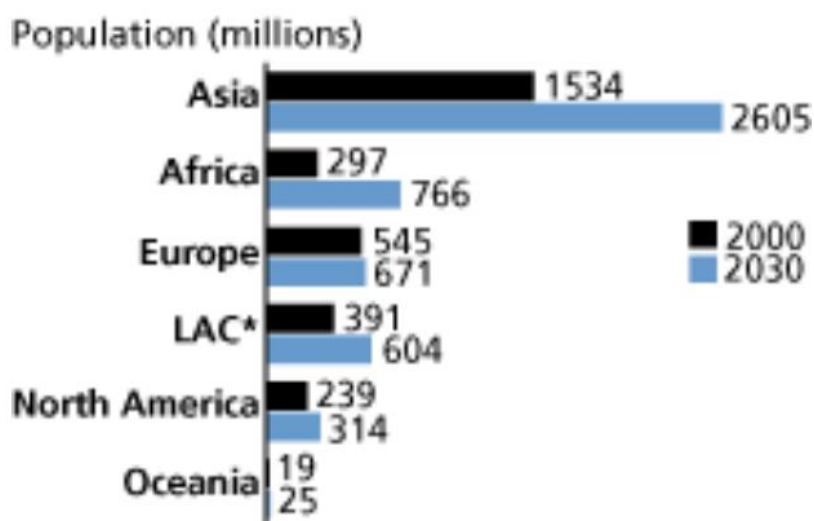
In the modern era, rural areas really need improvements and changes in infrastructure so that they are able to make the country more advanced. Many villagers are eventually forced to go to the city for medical treatment because of more adequate facilities. The distance and the high cost are one of the obstacles for the villagers who ignore their health and seek medical treatment in the city. The concentration and development of a country's infrastructure from the past until now has focused more on urban areas.

In the future, it is predicted that urban will remain the focal point of the country as well as a place of shelter for travelers. In the modern era, urban life is closely related to lifestyle. A lifestyle that includes consumption, exercise, rest and stress levels which are determinants of urban health.

### **2.1 Urban Public Health in Asia**

More than 60 percent of the increase in the world's urban population over the next three decades will occur in Asia, particularly in China and India, but also in Pakistan, Bangladesh, the Philippines and Vietnam. Asia will have a lower overall urbanization rate by 2030 53% than other regions - Africa will be slightly higher at 55%, while Latin America is projected to reach 83 percent - but Asia's total urban population will exceed 2.6 billion by 2030 , compared with 604 million in Latin America and 766 million in Africa (can be seen in the image below).

Urban Population by Region: 2000 and 2030



\*LAC = Latin America and the Caribbean.

Source: UN, World Urbanization Prospects: The 1999 Revision, 2000.

In developing countries such as Asia and Latin countries, the prospect of urbanization on a massive scale raises concerns that the world may not be able to sustain such large urban populations. The increasing concentration of the population is a fundamental challenge for providing economic opportunities, developing adequate infrastructure and housing that is suitable for habitation, as well as maintaining a healthy environment. In some less developed cities, many residents must be willing to live in slum areas, prone to flooding, and lack of public services.

Unlike other regions, Asia has five least developed countries with more than 100 million inhabitants - China, India, Bangladesh, Pakistan and Indonesia. These countries constituted 75 percent of Asia's population in mid-2001. By 2030, Iran, the Philippines and Vietnam will join forces, and together, these countries will make up 81 percent of Asia's population. The combined urban population of these 8 countries will grow by more than 1 billion people in the same period, accounting for about four-fifths of the total urban increase in Asia. The size of the population in Asia forces governments to cope with large urban increases in a very short time. The urban populations in China and India, for example, will grow to more than 340 million by 2030. This creates tremendous challenges in infrastructure provision, environmental management and employment.

Uneven globalization. Over the past two decades, Asia has surpassed other developing countries in terms of integration into the global economy, creating greater opportunities for urban development. However, this development has been uneven.

## 2.2 Urban Poverty

Many people with middle and lower income groups live in urban areas. The suburban community is quite tragic. Standard wage employment makes life difficult for suburban communities.

In 2020 to 2021 this year is the world's most difficult year, namely facing the Covid-19 pandemic outbreak. The whole world, both developed and developing countries, feel difficulties. Various sectors were severely damaged. The world economy was destroyed in an instant. In Asian countries, the economic, health and social impacts have changed drastically.

Many factories have closed due to the massive lockdown. Many employees are laid off so they have no more income, while the cost of living continues. The greatest impact is felt by urban communities. Starting from lockdowns, layoffs, and losing many lives had been felt beforehand by urban communities. On the other hand, the insignificant impact of Covid-19 was felt by rural communities. The addition of the population of the poor has increased, especially since the Covid-19 pandemic. Until 2021, the economic recovery will begin to improve, but there are still many poor people. The large number of victims resulted in the hospital being full of Covid-19 patients. Health is currently undergoing exams starting from 2020 to the present.

It can be concluded that urban poverty in the Asian region is at a high level, especially with the Covid-19 pandemic. To alleviate poverty in a country, the government in each country must be careful and fast in making decisions so that poverty, especially in urban areas, can be reduced.

### **2.3 Future Plan**

Many studies on urban areas have been linked to aspects of economic growth. Cities are seen as spaces that are created to accommodate investments that will lead to an increase in capital. However, the study of urban areas in developing countries has traditionally been of a lower priority compared to rural development.

Urban public health is projected to improve further with the presence of graduates in the health sector and health infrastructure. However, health in developing countries, especially Asia, still needs to be addressed. With the existence of studying or transferring studies, including sharing experiences and findings with developed countries, the health sector in developing countries will increase. However, the government must not forget the health infrastructure in rural areas, which is still minimal of everything.

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