INTRODUCTION

The world has completed significant development in reducing child morbidity and mortality over the past four decades[1,4]. Several factors, for instance applying high-impact child survival interventions, strengthening the health system, progresses in maternal education and family income, commitments of policymakers and donors, and setting Millennium Development Goals (MDGs) have contributed to child reduction global death rate[1]. Many countries in the world, including Yemen at the top of the list, have made insufficient or modest progress towards achieving MDG 4[1,4,5]. In Yemen, the under-five mortality rate has decreased significantly over the past forty years, and the country has achieved the Millennium Development Goal (MDG) of child survival[4,5]. Nevertheless, due to the aggression of foreign countries and siege on Yemen that began 6 years ago, child mortality rate has risen to a higher level than what was reported 40 years ago, in which, a child dies every 10 minutes from malnutrition and infectious diseases. Therefore, Yemen might...
remain be higher compared to the morbidity and mortality rates of many LMICs. Evidence-based assessment of child morbidity and the causes of childhood disease is known to provide a basis for planning national health strategies and tracking progress towards child survival goals. On the other hand, many LMICs, including Yemen, have brittle health management information systems and deficient vital record to monitor trends and risk factors for child disease and mortality. Therefore, it is necessary to systematically investigate the causes of childhood illnesses to guide policy makers to intervene to keep the child alive and prevent childhood diseases. The aim of this study was to investigate the trend of child morbidity in Yemen over the past forty years using data from a private health center. The results of this study can serve as part of the criteria for tracking child survival goals during the era of the Sustainable Development Goals (SDGs) and the health sector transformation plan in Yemen.

**METHODS**

Settings: Yemen is a country located at the southern tip of the Arabian Peninsula in western Asia. It is the second largest sovereign Arab country on the peninsula, and resides in 527,970 square kilometers (203,850 square miles). The coast extends for about 2,000 km (1,200 mi). It is bounded on the north by the Kingdom of Saudi Arabia, on the west by the Red Sea, on the south by the Gulf of Aden and the Guardafui Channel, and to the east by Oman. The territory of Yemen includes more than 200 islands, with the islands of Socotra in the Guardafui Channel. Yemen integrates to the group of least developed countries, referring to the many “severe structural obstacles to sustainable development.” In 2019, the United Nations described Yemen as the country most in need of humanitarian aid, with around 24 million people out of a total of 28.5 million, or 85% of its population, in need of urgent aid. As of 2020, the country ranked first in the Fragile States Index, and the second worst in the Global Hunger Index, being surpassed only by the Central African Republic. Despite the significant progress Yemen has made in expanding and improving the healthcare system over the past decades, the system remains severely underdeveloped. Total spending on healthcare in 2002 was 3.7 percent of GDP. In the same year, per capita spending on healthcare was very low, compared to other Middle Eastern countries - $ 58 according to UN statistics and $ 23 according to the World Health Organization.

According to the World Bank, the number of doctors in Yemen increased at a rate of more than 7 percent between 1995 and 2000, but as of 2004 there were still only three doctors for every 10,000 people. In 2003, Yemen had only 0.6 beds per 1,000 people. Health care services are especially scarce in rural areas. Health services cover only 25 percent of rural areas, compared to 80 percent of urban areas. Emergency services, such as the ambulance service and blood banks, are non-existent.

**RESULTS**

Eight thousand eight hundred and sixty-one children were diagnosed with health diseases and disorders. There was a significant increase in morbidity rates in the periods 1986-1995 where 30.1% of cases were identified, followed by 2016-2018 (25.9%) and these rates were significant where P<0.001. The results of Table 1 show that the disease rate decreased in 1996-2005 by 13.8%, then in 2006-2015 to 9.1% and then increased to 25.9% in 2016-2018 and the differences were statistically significant (p<0.001) (Table 1). When age groups of the children were considered, most of diseased children were in children under 1 year of age in which counts 42% of the total, followed by age group 1-5 years in which the rate was 41.3% and these high rates were statistically significant comparing to other age groups (p<0.001). However, in older children the rates were decreased to 13.2% in age group 6-10 year, more decreased to 3.3% in age group 11-15 years, and the lowest rate (0.19%) was in age group ≤16 Years. The trend of decreasing disease with age was statistically significant (P<0.001) (Table 2). When the sex of the children was taken into account, male patients were more prevalent at a significant rate equal to 54.5% compared to 45.5% of females, and this difference was statistically significant (P<0.001) (Table 2).

**Data sources**

Data were collected from private children Health Center in Sana’a (Sam Medical Center). The data was collected and analyzed in 4 months, starting on 15 June 2020 and ending on 26 August 2020, where the handwritten information (registers) was transferred and tabulated for the past forty years, as the center is considered one of the oldest private centers specialized in child care. The records included clinical and laboratory data of out-patient clinic visitors who were seeking treatment in the medical center. The frequency distribution of the different variables and the ratios of cases containing data on these variables were analyzed and their significance (P-value) was calculated using Chi-squared "N-1" test as recommended by Campbell and Richardson (2011) to compare proportions using EPI-Inf version 6 computing software. The study included 8,861 clinically diagnosed cases, of which 4,833 were males and 4,028 were females, and the ages ranged from birth to 16 years.

**Table 1: The distribution of diagnosed cases of children by years.**

| Years range   | Number of cases | %     | Significant level |
|---------------|-----------------|-------|-------------------|
| 1976-1985     | 1866            | 21.1  | <0.001            |
| 1986-1995     | 2671            | 30.1  | <0.001            |
| 1996-2005     | 1224            | 13.8  | <0.001            |
| *2006-2015    | 803             | 9.1   | Ref               |
| 2016-2018     | 2297            | 25.9  | <0.001            |
| Total         | 8861            | 100   |                   |

P-value was calculated using the "N-1" Chi-squared test as recommended by Campbell15 and Richardson 16 for comparing proportions. *Ref* used as a reference for comparison. *<0.05 = significant*
The predominant illnesses that occurred in sick children were respiratory disease (44.3%) (p<0.001), followed by gastrointestinal disease (30.0%) (p<0.001), while other diseases were 5.5% or less (Table 3). When looking at respiratory diseases, most respiratory infections were upper respiratory tract infections accounting for 78.7% of total respiratory infections, while LRTI accounted for only 19.9%. There was a detectable prevalence of pulmonary tuberculosis among children of 1.02% (40 cases) (Table 4).

DISCUSSION

In the current study, the predominant illnesses affecting sick children were respiratory disease (44.3%) (p<0.001), followed by gastrointestinal disease (30.0%) (p<0.001) (Table 3). This finding is similar to that reported in low-income countries such as Ethiopia, where diarrheal diseases, respiratory infection and neonatal syndromes remained the main causes of morbidity and mortality in children, especially under the age of five17. This high rate of disease among children in Yemen may be the result of widespread of unsafe sanitation and unsafe water supplies7. These risk factors were also the main risk factors for under-five child morbidity and mortality in low-income countries, but they all improved significantly during the MDG era in other countries while in Yemen these risk factors were reintroduced again in the 2016-2018 period (Table 2) because of the Saudi and Emirati aggression. Table 1 results show that the disease rate decreased in 1996-2005 by 13.8%, then in 2006-2015 to 9.1%. This decrease may be due to child survival interventions at the community level such as immunization and community management for major diseases such as pneumonia, malaria, diarrhea and other diseases were performed through the pioneering of HEP (Health Equivalency Program) in the period from 1978 to 2015 years, and the effect of high-impact interventions such as insecticide-treated nets (ITN) and immunizations19. The HEP includes trained and paid health extension workers who provide basic primary health care services at the community level. The HEP has improved health care practices for mothers and newborns and can contribute to reducing morbidity and mortality rates among children in Yemen18. The contribution of development partners in support of high-impact child survival interventions for instance the malaria control program and immunization can contribute significantly to reducing child morbidity in 1996-2005 (13.8%), and in 2006-2015 (9.1%). For example, malaria incidence and mortality in Yemen have decreased dramatically after the induction of artemisinin combination therapy (ACT) and insecticide-treated bed nets (ITN)19.

An analysis of the data (Table 2) was performed after the year 1996, because of the Saudi and Emirati aggression in 2015 (9.1%).

Table 2: The distribution of diagnosed cases of children by gender and age.

| Cases | % | Significant level |
|-------|---|------------------|
| Age groups | | |
| < 1 Year | 3721 | 42 | <0.001 |
| 1-5 Years | 3656 | 41.3 | <0.001 |
| 6-10 Years | 1173 | 13.2 | <0.001 |
| 11-15 Years | 294 | 3.3 | Ref |
| ≤16 Years | 17 | 0.19 | <0.001 |
| Gender | | |
| Male | 4833 | 54.5 | |
| Female | 4028 | 45.5 | <0.001 |

The predominant illnesses that occurred in sick children were respiratory disease (44.3%) (p<0.001), followed by gastrointestinal disease (30.0%) (p<0.001), while other diseases were 5.5% or less (Table 3). When looking at respiratory diseases, most respiratory infections were upper respiratory tract infections accounting for 78.7% of total respiratory infections, while LRTI accounted for only 19.9%. There was a detectable prevalence of pulmonary tuberculosis among children of 1.02% (40 cases) (Table 4).

DISCUSSION

In the current study, the predominant illnesses affecting sick children were respiratory disease (44.3%) (p<0.001), followed by gastrointestinal disease (30.0%) (p<0.001) (Table 3). This finding is similar to that reported in low-income countries such as Ethiopia, where diarrheal diseases, respiratory infection and neonatal syndromes remained the main causes of morbidity and mortality in children, especially under the age of five17. This high rate of disease among children in Yemen may be the result of widespread of unsafe sanitation and unsafe water supplies7. These risk factors were also the main risk factors for under-five child morbidity and mortality in low-income countries, but they all improved significantly during the MDG era in other countries while in Yemen these risk factors were reintroduced again in the 2016-2018 period (Table 2) because of the Saudi and Emirati aggression. Table 1 results show that the disease rate decreased in 1996-2005 by 13.8%, then in 2006-2015 to 9.1%. This decrease may be due to child survival interventions at the community level such as immunization and community management for major diseases such as pneumonia, malaria, diarrhea and other diseases were performed through the pioneering of HEP (Health Equivalency Program) in the period from 1978 to 2015 years, and the effect of high-impact interventions such as insecticide-treated nets (ITN) and immunizations19. The HEP includes trained and paid health extension workers who provide basic primary health care services at the community level. The HEP has improved health care practices for mothers and newborns and can contribute to reducing morbidity and mortality rates among children in Yemen18. The contribution of development partners in support of high-impact child survival interventions for instance the malaria control program and immunization can contribute significantly to reducing child morbidity in 1996-2005 (13.8%), and in 2006-2015 (9.1%). For example, malaria incidence and mortality in Yemen have decreased dramatically after the induction of artemisinin combination therapy (ACT) and insecticide-treated bed nets (ITN)19.

Table 3: The distribution of different diseases among children, 1976-2018.

| Diseases | Cases | % | Significant level |
|----------|-------|---|------------------|
| Respiratory | 3924 | 44.3 | <0.001 |
| Gastro Intestinal | 2687 | 30.3 | <0.001 |
| Childhood infectious | 486 | 5.5 | <0.001 |
| Skin | 458 | 5.2 | Ref |
| Nutritional Disorders | 346 | 3.9 | NS |
| UTI | 345 | 3.9 | NS |
| CNS | 273 | 3.1 | NS |
| Hematological disorder | 149 | 1.7 | NS |
| Heart | 118 | 1.33 | NS |
| Others | 75 | 0.46 | NS |
| Total | 8861 | 100 | |

P value was calculated uses the “N-1” Chi-squared test as recommended by Campbell15 and Richardson16 for comparing proportions. *Ref= used as a reference for comparison. <0.05 = significant.

Table 4: The distribution of different respiratory diseases among children in Sana’a city from 1978-2018.

| Respiratory diseases | No. | Percent |
|----------------------|-----|---------|
| URTI | 3087 | 78.7 |
| LRTI | 782 | 19.9 |
| Pulmonary TB | 40 | 1.02 |
| Stridor | 15 | 0.38 |
| Total | 3924 | 100 |

URTI= upper respiratory tract infections, LRTI= Lower respiratory tract infections, TB= Tuberculosis

Improved immunization coverage also be a factor to the significant decrease in measles mortality (>75%) over the past 40 years. Other immunizations coverage for children in Yemen, such as the pentavalent vaccine, pneumococcal, and rotavirus vaccines, has also improved recently20. Finally, the rapid social and economic development, waning of war, and political
stability in Yemen from 1980 to 2009 could have had a significant impact on child survival\textsuperscript{21}. Yemen must address the many environmental, behavioral and health bottlenecks to achieve continuous child survival goals during the SDG era. Reaching the SDG target of under-five mortality of less than 25 deaths per 1,000 will require continual development faster than the rate of development during the previous era. Doing so require targeting behavioral risk factors such as unsafe sanitation, unsafe water supplies, and household air pollution to decrease or eradicate deaths from diarrheal disease and LRI. Alternatively, other risk factors for child mortality, such as maternal illiteracy and bad practices\textsuperscript{22} will be focused on behavior change communication by the higher education institution. With the decrease infectious diseases, neonatal syndromes have emerged as the leading cause of death for children in Yemen. This could be due to low coverage (16\%) of institutional connectivity and many restricted accesses in the health system such as poor quality of care and a shortage of well-trained health works in tangential health facilities. Integrated neonatal interventions\textsuperscript{23,24} such as neonatal care at home, higher institutional childbirth coverage, and better management of neonatal syndromes in all health facilities through trained health workers can help achieve the goal of neonatal deaths during the SDG era. In the current study, malnutrition accounted for 3.9\% of childhood diseases (Table 3), and this confirms that malnutrition as a cause of death and a risk factor for other diseases remains a major health problem in Yemen, especially in the past six years\textsuperscript{25}. Many factors associated with malnutrition such as food insecurity and poor infant and child feeding practices\textsuperscript{26} need to be addressed through multi-sectoral approaches through community engagement and other sectors such as education and agriculture.

CONCLUSION

Respiratory diseases and gastrointestinal diseases might be remaining among the main causes of children’s diseases in Sana’a, Yemen. These findings call for better newborn and child recovery and survival interventions that focus on the key factors that lead to childhood disease.

LIMITATION OF THE STUDY

The current study does have some limitations. Firstly, the data we used is single center data which is why the results are geographically limited. Secondly, there are no clear diagnostic criteria for the different types of diseases included in the study. However, this study used a broad source of data time and applied rigorous methodology to validate the data.

CONFLICT OF INTEREST

No conflict of interest associated with this work.

AUTHOR’S CONTRIBUTION

The first author presented the data and the first and second authors analyzed the data and wrote, revised and edited the paper.

REFERENCES

1. Wang H, Liddell CA, Coates MM, \textit{et al}. Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2014; 384(9947):957–79. 
https://doi.org/10.1016/S0140-6736(14)60497-9

2. USAID. Child survival: call to action. Ending preventable child deaths. 2014. 
https://www.usaid.gov/a-promise-renewed

3. UNICEF. Committing to the child survival: A promise renewed. Progress report 2013.

4. World Health Organization. Levels and trends of child mortality, WHO; 2015.

5. Al-Shamahy HA, Hanash SHA, Rabbad IA, \textit{et al}. Hepatitis B Vaccine Coverage and the Immune Response in Children under ten years old in Sana’a, Yemen. Sultan Qaboos Univ Med J 2011; 11(1): 77–82. PMID: 21509212

6. World Health Organization, UNICEF, UNFPA The World Bank, Trends in maternal mortality 1990 to 2008, estimates developed by WHO, UNICEF, UNFPA and the world bank, WHO Press 2010, Geneva, Switzerland. 
https://www.who.int/reproductivehealth/publications/monitoring/9789241500265/en/

7. United Nations Development Programme. Human development report 2015. Work for human development. New York: United Nations; 2015.

8. GBD 2015 Eastern Mediterranean Region Collaborators, Mokdad AH. Danger ahead: the burden of diseases, injuries, and risk factors in the eastern Mediterranean region, 1990–2015. Int J Public Health. 2017;1–13. 
https://doi.org/10.1007/s00728-017-1017-y

9. McLaughlin, Daniel. Yemen. Bradt Travel Guides 2008. p. 3. ISBN 978-1-904621-21-2.

10. United Nations. LDCs at a Glance | Department of Economic and Social Affairs”. Economic Analysis & Policy Division | Dept of Economic & Social Affairs | United Nations. 25 May 2008. Retrieved 4 Nov 2020.

11. United Nations. Least Developed Countries (LDCs) | Department of Economic and Social Affairs. Economic Analysis & Policy Division | Dept of Economic & Social Affairs | United Nations. 23 September 2010. Retrieved 4 Nov 2020.

12. United Nations. "Yemen: 2019 Humanitarian Needs Overview [EN/AR]", Relief Web. United Nations Office for the Coordination of Humanitarian Affairs (OCHA). 14 February 2019. Retrieved 3 Nov 2020.

13. Fragile states index. "Global Data | Fragile States Index". Retrieved 29 July 2020.

14. Library of Congress Federal Research Division. Yemen country profile. (December 2006). This article incorporates text from this source, which is in the public domain.

15. Campbell I. Chi-squared and Fisher-Irwin tests of two-by-two tables with small sample recommendations. Statistics in Medicine 2007; 26:3661–3675. 
https://doi.org/10.1002/sim.2832

16. Richardson JIE. The analysis of 2 x 2 contingency tables - Yet again. Statistics in Medicine 2011; 30:890. 
https://doi.org/10.1002/sim.4116

17. Deribe W, Tesemma GA, Deribe K. Trends, causes, and risk factors of mortality among children under 5 in Ethiopia, 1990–2013: findings from the Global Burden of Disease Study 2013. Population Health Metrics 2016; 14:42
18. United Nations Children’s Fund. Yemen situation report. 2012.
19. Al Rukeimi AD, Al Shamahy HA, et al. Association of Cytomegalo-virus and rubella virus infections in pregnant women with bad obstetric history. W J Gynecol Women’s Health 2019; 2(3):1-5.
https://doi.org/10.33552/WJGWH.2019.02.000538
20. United Nations Children’s Fund. Malnutrition amongst children in Yemen at an all-time high, warns UNICEF. 2016.
21. El Bcheraoui C, Jumaan AO, Collison ML, et al. Health in Yemen: losing ground in war time. Global Health 2018; 14 (42):4-9.
https://doi.org/10.1186/s12992-018-0354-9
22. World Health Organization. Yemen electronic disease early warning system weekly report. Geneva: World Health Organization; 2017.
https://doi.org/10.2196%2FFI4295
23. Al Rukeimi AAD, Al Shaibani E M, Al Shamahy HA, et al. Uterine rupture and associated factors during labor amongst women delivered in Saudi Hajjah hospital in Hajjah City North West Yemen. W J Gynecol Women’s Health 2018; 1(2):1-8. WJGWH.MS.ID.000508.
https://doi.org/10.33552/WJGWH.2018.01.000508
24. Bang AT, Bang RA, Baitule SB, Reddy MH, Deshmukh MD. Effect of home based neonatal care and management of sepsis on neonatal mortality: field trial in rural India. Lancet 1999; 354(9194):1955–61.
https://doi.org/10.1016/s0140-6736(99)03046-9
25. World Food Program, Food and Agriculture Organization of the United Nations, United Nations Children’s Fund, Yemen Food Security and Agriculture Cluster, Yemen Ministry of Public Health, Yemen emergency food security and nutrition assessment (EFSNA)–2016, preliminary results for public release. 2016.
26. Getahun Z, Urga K, Genebo T, Nigatu A. Review of the status of malnutrition and trends in Ethiopia. Ethiopian J Health Dev 2001; 15(2):55–74.
https://doi.org/10.4314/cjhd.v15i2.9880