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TRENDS IN MORTALITY AMONG ADOLESCENTS
AND YOUNG ADULTS IN LEBANON FROM 2017 TO 2022

by
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ABSTRACT OF THE THESIS OF

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Adolescence is a critical phase during which individuals develop habits that can significantly impact their future health and wellbeing. While youth is often perceived as a healthy period of life, it is alarming that over 1.4 million young people die annually, with a significant number of deaths occurring in low and middle-income countries. In Lebanon, there is a lack of recent studies that describe mortality trends and underlying causes of death (UCOD) among adolescents and young adults. Hence, this study aims to fill this crucial gap by examining mortality trends and common UCOD between 2017-2022.

Adolescent mortality data in Lebanon from 2017 to 2022 were collected from the Ministry of Public Health's (MOPH) database. The three parameters to describe the outcome of interest were time, place, and persons. A Pearson's chi-square test was used to assess trend changes, with a p-value of ≤ 0.05 indicating significance.

In Lebanon, a significant increase in mortality was observed among 10-14-year-old adolescents from 2017 to 2022. Young adults 20-24 had the highest percentage of death among all years compared to younger age groups. The highest percentage of deaths was noted in 2021 (18.5%), and males had a higher death rate than females (68.9% vs. 31.1%). The most common UCOD was external causes of death (35.7%), followed by cardiovascular/circulatory system diseases (20.4%) and neoplasms (9.2%). Adolescents aged 15-24 are more likely to die from external causes, while those aged 10-14 are more likely to die from neurological diseases. Mount Lebanon had the highest death rate (26%), with a significant increase in deaths in South Lebanon over the years.

In conclusion, as mortality rates increase, particularly among younger age groups, there is a need to prioritize adolescent and young adult health on the national agenda to develop and implement evidence-based policies and reduce the influence of the leading UCOD. This study serves as an essential quality indicator (QI) of the current data collected by the government surveillance system, highlighting the need to further enhance data validity and reporting.

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ABBREVIATIONS

Abbreviation	Explanation
WHO	World Health Organization
COVID-19	Coronavirus disease 2019
UCOD	Underlying causes of death
MENA	Middle East and North Africa
NCDs	Non-communicable diseases
HIV	Human immunodeficiency virus
AIDS	Acquired immunodeficiency syndrome
COD	Causes of death
GBD	Global Burden Disease
MOPH	Ministry of Public Health
ICD-10	International Classification of Diseases, Tenth Revision
SARS	Severe acute respiratory syndrome

CHAPTER I

INTRODUCTION

A. Rationale

Adolescence is a critical period of transition from childhood to adulthood, during which individuals' adopted health behaviors and habits can influence one's lifespan [1]. The World Health Organization (WHO) characterizes adolescence as the period between 10 and 19 years when young individuals encounter physical, cognitive, emotional, and social development [2]. Adolescence can also be classified into three groups: young (10-14), middle (15-19), and late (20-24); each phase is distinguished by its unique development and characteristics [3, 4]. Adolescent health profiles may vary between countries, reflecting the national health strategies and the effectiveness of their implemented prevention policies [5]. While youth is often perceived as a healthy period of life, it is alarming that over 1.4 million young people (aged 10-19) die annually, with a significant number of deaths occurring in low and middle-income countries [6, 7]. However, many of the diseases from which adolescents die could be prevented [8]. Additionally, the WHO declared that two-thirds of premature deaths and one-third of the total illnesses which burden adults are due to conditions or behaviors that were initiated during adolescence [9].

Several factors might influence adolescents' health outcomes, including social determinants of health, risk and protective factors, and adolescents' health-related behaviors [4]. Although young people are at a lower risk of mortality and morbidity from coronavirus disease 2019 (COVID-19) compared to older adults, they are still vulnerable

to the indirect consequences of the pandemic, which could have a long-lasting impact on their health; these impacts warrant further investigation [10].

In Lebanon, adolescents and young adults comprise almost 1.7 million of the total population [11]. This population in Lebanon have endured several crises that have impacted their health and led to deterioration in their quality of life and access to quality services, including the country's economic collapse, the COVID-19 pandemic, and the Beirut blast. As a result, they have had to deal with various health, financial, and social challenges [12]. Although it is essential to invest in productivity gains in Lebanon by improving the capacity of its young population there is a lack of data regarding adolescent and young adult mortality and the underlying causes of death (UCOD) in the country. Furthermore, there is a need for accurate and systematic reporting of relevant data to understand the situation and develop effective interventions and future policies. To the best of our knowledge, more data are needed to comprehensively describe mortality trends and UCOD among adolescents and young adults in Lebanon. Therefore, this study aims to fill this crucial gap by characterizing and examining the mortality trends among adolescents and young adults in Lebanon and identifying common UCOD between 2017-2022. The evidence generated from this study can be used to develop interventions and policies that address the needs of adolescents and young people in Lebanon, thereby decreasing mortality rates among this population. Furthermore, this study can provide a unique opportunity to build risk prevention methods across the Middle East and North Africa (MENA) region by improving our understanding of the UCOD associated with early mortality in Lebanon.

B. Literature Review

Over 50% of adolescents are growing up in countries that are burdened with multiple health problems, including diseases related to poverty, such as infectious diseases, malnutrition, poor sexual and reproductive health, as well as injuries, violence, and non-communicable diseases (NCDs) [5]. Consequently, it is vital to address the increase in preventable diseases and implement strategies to reduce various risk factors associated with these conditions [5]. In addition to the increasing risk of morbidity, mortality rates among this population have been rising worldwide in the last three decades [13]. Globally, based on a systematic analysis of population data, 2.6 million deaths occurred in 2004 among individuals aged 10-24 years, and almost all these deaths (97%) occurred in low- and middle-income countries, with two-thirds taking place in sub-Saharan Africa and Southeast Asia. Death causes vary by region and gender, with maternal diseases composing the highest risk of mortality among females (15%). Human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) and tuberculosis constituted 11% of all deaths. However, traffic accidents were the dominant mortality cause for male and female adolescents in several countries, accounting for 14% and 5%, respectively. Concerning violence and suicide it comprised 12% of male deaths and 6% of all deaths respectively [14]. In 2019, 32.7% of deaths among young people aged 10-24 years were caused by external causes such as transport injuries, unintentional injuries, interpersonal violence, or conflict, while 8.2% were caused by self-harm [15]. Concerning deaths due to communicable and maternal diseases, between 1980 and 2019, the proportion of deaths has declined worldwide. This trend was observed in Latin America, the Caribbean, South Asia, Southeast Asia, East Asia, the Caribbean, North Africa, and the Middle East [15].

In the MENA region the young population constitutes almost 140 million, representing a quarter of the population between 10 and 24. This young population presents an opportunity to promote health and well-being for individuals and communities, advance sustainable development, and create a positive impact for future generations. Especially, many disease burdens and deaths among young people in this region could be prevented [16]. The top mortality causes in this region contributing around 15% or more were noted to be cardiovascular/circulatory diseases and transport injuries [17]. In 2019 mortality rates specific for accidents and injuries among 10–24-year-old adolescents were relatively high in the MENA region with the highest mortality in Yemen (87 per 100,000 deaths), followed by Oman (59 per 100,000 deaths), Libya (53 per 100,000 deaths), Iraq (50 per 100,000 deaths) and Saudi Arabia (44 per 100,000 deaths). In contrast, while still topping the list of causes of death (COD) the mortality rates specific for accidents and injuries among adolescents was estimated to be 23 per 100,000 deaths [16]. As for NCDs it accounts for nearly half of the disease burden in girls and over one-third of the burden in boys in the MENA region. The region's primary causes of non-communicable disease burden are headache, cardiovascular disease, musculoskeletal disorders, and skin conditions. Additionally, gynecological disorders are also a leading cause of non-communicable disease burdens among girls in this region [16]. However, the MENA region has a low burden of communicable diseases among young people (6% of all deaths), except in Yemen, Sudan and Djibouti [16]. Concerning mental health diseases in 2019, an estimated 22.5 million young people, which is around 1 in 6, were living with a mental health disorder, though only 4,390 deaths caused by suicide [16].

In Lebanon, based on a report from the Global Disease Burden (GBD), the common projected top COD among female and male adolescents aged 10-24 years old were cancers, cardiovascular diseases, and transport injuries. However, self-harm was found to be a top death cause in females versus interpersonal violence in males [16]. The high percentage of deaths in Lebanon due to preventable diseases, including transportation accidents and intentional and unintentional injuries, raises questions about road safety and driving measures among adolescents. A multicenter retrospective study analyzing data on transport-related injuries and fatalities among children aged between 0 and 17 years in Lebanon during a period of three years (2015-2017) found that the morbidity and mortality rates due to transport injuries increased with age. The study noted significantly higher proportions of injuries and fatalities among adolescents aged 15 (9%), 16 (11%), and 17 (14%) [18]. On top of that, several humanitarian crises that have occurred in Lebanon since 2019, such as the country's economic collapse, the Beirut Blast, and the COVID-19 pandemic, have left adolescents and young adults with negative impacts that threaten their health and well-being. For example, many young people have been forced to drop out of school due to financial barriers, which has led to an increased rate of child labor and the marriage of minor girls. Furthermore, the crises have caused acute malnutrition and violence among this target population, which have further exacerbated the situation [12]. Additionally, due to political instability, corruption, and financial crisis, many people in Lebanon, especially adolescents and young adults, faced difficulty accessing and affording healthcare [12, 19]. As a result, adolescents in Lebanon have become more vulnerable to mental health problems and thoughts of suicide [20]. Studies on trends in mortality among adolescents and young adults in Lebanon have yet to be developed, especially now that such data are available through a national surveillance

system recently established by the Ministry of Public Health (MOPH). Hence, this study presents an opportunity to better understand mortality trends and UCOD among this age group using real data, which aims to support future interventions to reduce the associated risks of premature deaths among the upcoming generation of citizens in Lebanon.

C. Objectives

1. To identify common UCOD among adolescents and young adults (aged 10-24) in Lebanon between 2017-2022.
2. To characterize the mortality trends among adolescents and young adults (aged 10-24) in Lebanon between 2017-2022.

D. Research Questions

1. What are the common UCOD among adolescents and young adults (10-24 years) in Lebanon between 2017 and 2023?
2. Is there a significant change in mortality trends among adolescents and young adults (10-24 years) in Lebanon between 2017 and 2023 according to year, region, sex, and age groups?

CHAPTER II

METHODS

A. Study design and Data source

This is a descriptive study characterizing the trends of mortality among adolescents and young adults (10-24 years) in Lebanon between 2017 and 2022. Data were retrieved from the MOPH aggregated surveillance database, which was obtained from 145 public and private hospitals in Lebanon.

C. Concepts and Measures

i. Outcome variable

In this analysis, the outcome of interest is the “absolute number of death cases” classified in eleven largest UCOD groups, according to the International Classification of Diseases, Tenth Revision (ICD-10) causes of death (Appendix I).

ii. Independent variables

The outcome of interest will be described using three parameters: time, place, and persons.

-Time: UCOD will be presented by year

-Place: UCOD will be presented by geographic regions: Akkar, North Lebanon, Northern Bekaa (Baalback and Hermel), Central Bekaa (all other qadas), Beirut, Mount Lebanon and South Lebanon

-Persons: UCOD will be presented using the following variables: Age [Young adolescence (10-14 years); middle adolescence (15-19 years); late adolescence (20-24 years)] and sex

C. Analysis Plan

All variables were tabulated and described using frequency and percentage. Trends were analyzed over the years of reporting for all UCOD and compared to international findings [15, 16]. These temporal trends were subsequently stratified by age groups, sex, and region. Changes in relative proportions from the first observation in 2017 to the last one in 2022 were assessed using a Pearson's chi square test (X^2) for trends. A p-value ≤ 0.05 indicated a significant upper or lower trend. Data were analyzed through SPSS for Windows version 22.

D. Ethical considerations

This research uses surveillance data from the MOPH routine reporting system. All variables are received without identifiers. AUB IRB review and approval is not required in case of assessing data for deceased individuals.

CHAPTER II

RESULTS

A. UCOD by the demographic variables: sex & age

Table 1 details the distribution of specific UCOD between 2017 and 2022 by age groups. A total of 2776 deaths were reported among adolescents and young adults during this period. Overall, the most reported UCOD was “external causes of death” (35.7%), which includes causes such as accidents (31%), intentional self-harm (1.6%) and assault (1.1%). Deaths from cardiovascular/circulatory system diseases (20.4%) comprising several forms of heart disease (14.8%) including pericarditis, myocarditis, cardiac arrest, and heart failure in addition to cerebrovascular diseases (3.4%) were second. Deaths from neoplasms were third (9.2%), involving deaths primarily due to malignant neoplasms of the lip, oral cavity and pharynx, in addition to lymphoma and leukemia. UCOD was undetermined in 9.4% of cases. The relative death proportions increased with age, from 23.3 % in the (10-14) group of adolescents to 35.7 % and 41.0 % among older age groups (15-19) and (20-24), respectively. When stratifying by age groups, two significant differences emerged. The relative proportion of deaths from external causes was significantly higher in older age groups (15-24) compared to younger ones (10-14) (P-value=0.01). On the other hand, deaths due to diseases of the nervous system were represented considerably more in the younger age group compared to older ones (P-value <0.01). Deaths from nervous diseases encompass episodic and paroxysmal disorders such as epilepsy, migraine, headache and sleep disorders, cerebral palsy, other paralytic syndromes, and other disorders of the central nervous system such as the Horner

syndrome, and disorders affecting the autonomic nervous system. Details are presented in Table 1.

Table 2 presents the distribution of UCOD by sex. The total proportion of deaths was more than double among males (69%) compared to females (31%). Significant differences appeared in relative proportions within specific UCODs when stratified by sex. While the relative proportion of deaths by external causes is the higher cause for both genders, it was significantly higher among males compared to females (41.7 % versus 22.5%). The relative proportions among females were significantly higher compared to males in deaths caused by neoplasms (11.7 % versus 8.1 %), respiratory diseases such as pneumonia and influenza (6.3 % versus 3.9 %), endocrine/metabolic (2.7 % versus 1.5 %), digestive diseases (3.6 % versus 1.8 %), and mental health diseases (1.2% versus 0.4%). No significant differences in the relative proportion of “undetermined” causes were found between the two genders. Details are presented in Table 2.

B. UCOD by historical trends

Table 3 considers the distribution of UCODs per year and reveals no significant change in the trend among all UCODs except for deaths due to “external causes”, which decreased significantly from 2017 (36.9%) to 2022 (29.7%) (p-value for trend= 0.02*). The mean percentage of deaths expected per year is 16.7% (SD= 1.7). There were no significant changes in trends in those proportions from year to year, except for the year 2019, which showed a substantial reduction in relative death proportion (13.8%). Details are presented in Table 3.

Table 4 shows the historical trends of UCOD among adolescents and young adults in Lebanon by age group and sex. When stratified by age groups, significant trends started

appearing. The relative proportions in the age group (10-14) increased significantly compared to the older age group (15-24). The UCOD, which increased most significantly within this age group, was infectious diseases. However, when stratified by sex, the relative proportions showed no significant historical differences (Figures 1 & 2). Details are in Table 4.

C. UCOD by geographical variables

Table 5 shows the trends in the UCOD among adolescents and young adults in Lebanon by governorate. Mount Lebanon had the highest death rate (27.2%), followed by South Lebanon (20.2%), Akkar (12.6%), North Lebanon (11.6%), Northern Bekaa (10.4 %), Central Bekaa (9.4%), and Beirut (8.5%). When comparing with the relative distribution of the Lebanese population in various governorates [21], it appears that Mount Lebanon is much less represented than expected. In contrast, Akkar is much more represented than expected. Between 2017 and 2022, there were no significant differences in trends among governorates, except in South Lebanon, where the relative proportion increased significantly from 14% in 2017 to about 21% in 2022. In contrast, the relative death proportion in Central Bekaa revealed a significant reduction from 18% in 2017 to 10% in 2022. Details are presented in Table 5.

Table 6 shows the specific UCODs by governorate among adolescents and young adults in Lebanon between 2017 and 2022. No remarkable differences in the order of frequency or the top causes of death appeared between governorates. External causes of deaths topped the list for all governorates. However, Northern Lebanon and Northern Bekaa had a remarkably higher proportion of deaths from external causes (40.8%) when

compared to the total external COD of all regions (35.6%). Further details are presented in Table 6.

CHAPTER IV

DISCUSSION

A. Summary of findings and data limitations

In Lebanon, the most common UCOD among adolescents and young adults (10-24 years) were external causes of death, cardiovascular/circulatory diseases, and neoplasms. The relative distribution indicates that the risk of dying increases with age. Some specific UCOD also varied by age: older adolescents were more at risk of dying from various external causes of death. In contrast, younger ones were more likely to die from neurological disorders. Almost two-thirds of deaths occur in males and the rest in females. These findings are comparable to those reported regionally [16, 17] or internationally [15]. There were no differences in yearly proportions during the period analyzed except in 2019, in which the relative death proportion exhibited a notable reduction that can only be explained as an artifact. This was most likely due to a temporary lapse in the reporting system since Lebanon was impacted by a group of adverse events that might have affected the data collection at the hospital sources. There were some historical differences among governorates, which may be associated with contextual and socio-economic variables. However, the validity of this finding is limited by the fact that the current civil registration system in Lebanon registers death cases based on their family's original district, which may not be, for most Lebanese, the district in which they reside and die. Another limitation of this analysis is its short duration of six years, which tends to magnify random variations from year to year. In a small country like Lebanon, even minor disruptions in the system, such as reporting delays due to personnel changes in different regions or changes in hospitalization patterns, can impact

data reporting and the analysis results. Fortunately, deaths outside the hospital, which may lead to cases not being recorded in the MOPH system, are likely to be more for those elderly dying at home and less potential for adolescents and young adults. Additionally, smoother trends would probably start if the study evaluated more extended periods.

B. What are unexpected findings in this analysis?

Our study showed that the top five leading causes of mortality among adolescents and young adults in Lebanon between 2017 and 2022 were external causes of death (ex, accidents, assault, and intentional self-harm), cardiovascular /circulatory system diseases, neoplasms, diseases of the nervous system and respiratory diseases. These mostly preventable causes are similar to the MENA region's findings [17]. Regional findings do not show a high mortality rates due to communicable diseases [16]. Similarly, our research shows that only 2.5% of deaths were attributed to infectious and parasitic diseases. This is likely due to the epidemiological transition, which has caused a shift in the burden of disease from communicable and maternal causes to non-communicable chronic diseases [22, 23]. It has been reported that a significant number of adolescents in Lebanon are dealing with mental health disorders [24, 25]. However, despite this high prevalence, our analysis and regional findings suggest that the high occurrence of these disorders does not result in a high number of deaths. Our study revealed that only 0.6% of adolescents and young adults died due to mental health disorders. Additionally, in the MENA region in 2019, it was estimated that 1 in 6 young people (22.5 million individuals) were living with a mental disorder, and there were nearly 4,390 deaths due to suicide [16]. This underreporting may be attributable to the stigma surrounding mental health in the regional culture. Furthermore, as expected, due to the epidemiological

transition, our study also found higher relative proportions of deaths from non-communicable diseases, including cardiovascular/circulatory (20.4%), neoplasms (9.2%), and nervous diseases (5.4%). These alarming findings highlight the importance of prevention, even at the earliest ages, to promote healthy lifestyles and steer young people away from unhealthy habits such as lack of exercise, smoking, and poor dietary patterns [26]. There seems to be a slow but steady increase in the absolute number of deaths in Lebanon, going from 461 in 2017 to 478 in 2022, with a peak of 514 in 2021. Nevertheless, our findings suggest that young people (10-14) in Lebanon are becoming more vulnerable in recent years to death, mostly from external causes of death and infectious diseases. The infectious disease trend was limited to 2019-2020 and started reverting to baseline from 2021. This trend is likely related to the COVID-19 pandemic, which intervened during those years. On the other hand, the increase in deaths due to external factors is likely due to the increase of refugee adolescents and young adults who are exposed to adverse social and environmental conditions [27]. Another potential factor could be the increasing number of adolescents and young adults in Lebanon who are forced to leave their educational institutions due to the economic crisis and enter the labor field [28]. Besides, the increasing acts of violence, accidents and assault could be because of the broken legal system and loose laws in Lebanon, which tend to facilitate crimes and increase external causes of death [29]. On top of that, young adolescents are less likely to cope with such external factors and conditions compared to older age groups; this could also explain why the relative proportion of deaths has increased in younger adolescents compared to older age groups.

C. Quality assurance in mortality data

The quality of mortality analyses is directly related to the quality of the data retrieved by the surveillance system. In our analyses, two factors could have affected the quality of the data: missing cases and incomplete reporting. The incomplete reporting is shown by a substantial 9% of reports which arrive at MOPH with an “undetermined” UCOD. This vital quality indicator (QI) did not vary by age group, sex, year, or region, and it could be due to poor performance by the individuals recording the information at the source and insufficient follow-up at the central level to rectify this issue. The persistence of a poor QI throughout the years of this analysis requires further investigation and eventual correction. On the other hand, there is no significant under-reporting since the relative proportions of deaths reported yearly have been slowly increasing.

CHAPTER V

CONCLUSION AND RECOMMENDATIONS

This study examined the change in death proportion among adolescents in Lebanon according to age group, sex, and region between 2017 and 2022. After this analysis, we suggest some recommendations.

1. Findings indicate the importance of implementing preventive policies and measures to address the leading causes of death among adolescents' population particularly external factors.
2. Establishing continuous monitoring of mortality trends in Lebanon is crucial, as the validity of evidence becomes more significant if analysis involves an extended period. However, such tracking requires a collective effort and active participation of those in the public sector or at MOPH, who can benefit from the resources available in civil society and the academic sector.
3. Enhancing the quality of data entering the MOPH registry is critical. It is crucial to utilize additional resources to ensure the accuracy and reliability of the data, thereby enhancing the quality of the outcomes and reducing the undetermined causes of death.
4. Healthcare access should be guaranteed for this promising age group, irrespective of their parent's coverage status. This is crucial for screening services, managing chronic conditions, and ensuring efficient first aid and emergency care availability across all regions. Such recommendations are essential during periods of economic instability in the country, as it becomes increasingly challenging to afford specific procedures or direct services for adolescents with life-threatening conditions.
5. Awareness campaigns are recommended to promote healthy lifestyles among adolescents and young adults in Lebanon. These campaigns should focus on physical activity, smoking cessation, responsible alcohol consumption, and healthy eating habits. Integration into school and university activities is essential. Additionally, policies should be developed, possibly in collaboration with the

Ministry of Social Affairs, to raise awareness among at-risk adolescents outside the educational system.

In conclusion, there is a pressing need to adapt to the growing global burden of adolescent mortality, tackle inequities wherever they exist, and improve both the availability and quality of mortality data for this age group. Enhancing global adolescent mortality rates necessitates addressing the vulnerabilities of this age group, especially among younger adolescents, who are often overlooked.

APPENDIX I

ICD-10 CATEGORIES[30]

Chapter I (A00-B99):

This includes certain infectious and parasitic diseases involving intestinal infectious diseases (ex: cholera, salmonella, typhoid fever), infections with a sexual mode of transmission (ex: syphilis), bacterial, viral, and other infectious agents (ex: infections caused by streptococcus A, B & Escherichia coli, Human immunodeficiency virus [HIV] and other infectious agents).

Chapter II (C00-D48):

This includes neoplasms involving malignant neoplasms (ex: malignant neoplasm of brain, thyroid, breast, and skin), benign neoplasms & neoplasms of uncertain or unknown behavior.

Chapter III (D50-D89):

This includes diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism involving nutritional anemias, hemolytic anemias, and other diseases of the blood and blood forming organs.

Chapter IV (E00-E90):

This includes endocrine, nutritional, and metabolic diseases involving nutritional deficiencies, disorders of the thyroid gland, diabetes mellitus, obesity, and other metabolic disorders.

Chapter V (F00-F99):

This includes mental and behavioral disorders (F00-F99) involving those due to psychoactive substance use, schizophrenia, mood disorders, and psychiatric disorders.

Chapter VI (G00-G99):

This includes diseases of the nervous system involving inflammatory diseases of the central nervous system (CNS) (ex: meningitis), demyelinating diseases of the CNS (ex: multiple sclerosis), & episodic and paroxysmal disorders (ex: epilepsy, migraine).

Chapter IX (I00-I99):

This includes diseases of the circulatory system involving including hypertensive diseases, ischemic heart disease, acute rheumatic fever, cerebrovascular diseases, and other forms of heart disease.

Chapter X(J00-J99):

This includes diseases of the respiratory system involving pneumonia, influenza, acute upper respiratory infections (ex: acute tonsillitis and pharyngitis), acute lower respiratory infections (ex: bronchitis), chronic lower respiratory diseases (ex: asthma) and other respiratory diseases.

Chapter XI (K00-K93):

This includes digestive system diseases involving the liver, gallbladder, biliary tract, pancreas, stomach, duodenum, and other digestive disorders.

Chapter XVIII (R00-R99):

This includes symptoms, signs, and abnormal clinical and laboratory findings. This chapter encompasses less well-defined conditions and symptoms without a final diagnosis. It could refer to multiple diseases or body systems. Practically all categories in the chapter could be designated 'not otherwise specified', 'unknown etiology', or 'transient'. Noting that during analysis missing values were also added to this category.

Chapter XX (V01-Y98):

This includes external causes of mortality such as accidents (ex: transport accidents, falls), intentional self-harm, assault, complications of medical and surgical care.

APPENDIX II

TABLES AND FIGURES

Table 1. Underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 by age groups (N=2776 deaths)

n (%)	10-14	15-19	20-24	Total	P-value
External causes of death	194 (19.6) (30.0)	372 (37.5) (37.5)	426 (42.9) (37.4)	992 (100) (35.7)	0.01*
Diseases of the circulatory/cardiovascular system	131(23.2) (20.3)	204 (36.1) (20.6)	230 (40.7) (20.2)	565 (100) (20.4)	0.99
Undetermined causes of death	53 (20.2) (8.2)	87 (33.2) (8.8)	122 (46.6) (10.7)	262 (100) (9.4)	0.24
Neoplasms	65 (25.4) (10.1)	100 (39.1) (10.1)	91 (35.5) (8.0)	256 (100) (9.2)	0.39
Diseases of the nervous system	49 (32.5) (7.6)	53 (35.1) (5.3)	49 (32.5) (4.3)	151 (100) (5.4)	<0.01*
Diseases of the respiratory system	36 (28.1) (5.6)	43 (33.6) (4.3)	49 (38.3) (4.3)	128 (100) (4.6)	0.19
Infectious and parasitic diseases	22 (31.4) (3.4)	17 (24.3) (1.7)	31 (44.3) (2.7)	70 (100) (2.5)	0.11
Diseases of the digestive system	18 (27.3) (2.8)	22 (33.3) (2.2)	26 (39.4) (2.3)	66 (100) (2.4)	0.46
Endocrine, nutritional and metabolic diseases	12 (23.5) (1.9)	22 (43.1) (2.2)	17 (33.3) (1.5)	51 (100) (1.8)	0.99
Diseases of the blood and blood forming organs	9 (19.1) (1.4)	20 (42.6) (2.0)	18(38.3) (1.6)	47 (100) (1.7)	0.60
Mental and behavioral disorders	4 (22.2) (0.6)	4 (22.2) (0.4)	10 (55.6) (0.9)	18 (100) (0.6)	0.99
Other causes**	53 (31.2) (8.2)	47 (27.6) (4.7)	70 (41.2) (6.1)	170 (100) (6.1)	NA
Total	646 (23.3) (100)	991 (35.7) (100)	1139 (41.0) (100)	2776 (100) (100)	

*Statistically Significant

**Other causes include diseases of musculoskeletal system and genitourinary system.

NA: Not applicable

Table 2. Underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 by sex (N=2776 deaths)

n (%)	Females	Males	Total	P-value
External causes of death	194 (19.6) (22.5)	798 (80.4) (41.7)	992 (100) (35.7)	<0.01*
Diseases of the circulatory/cardiovascular system	176 (31.2) (20.4)	389 (68.8) (20.3)	565 (100) (20.4)	0.99
Undetermined causes of death	83 (31.7) (9.6)	179 (68.3) (9.4)	262 (100) (9.4)	0.83
Neoplasms	101 (39.5) (11.7)	155 (60.5) (8.1)	256 (100) (9.4)	<0.01*
Diseases of the nervous system	56 (37.1) (6.5)	95 (62.9) (5.0)	151 (100) (5.4)	0.10
Diseases of the respiratory system	54 (42.2) (6.3)	74 (57.8) (3.9)	128 (100) (4.6)	<0.01*
Infectious and parasitic diseases	27 (38.6) (3.1)	43 (61.4) (2.2)	70 (100) (2.5)	0.19
Diseases of the digestive system	31 (47.0) (3.6)	35 (53.0) (1.8)	66 (100) (2.4)	<0.01*
Endocrine, nutritional and metabolic diseases	23 (45.1) (2.7)	28 (54.9) (1.5)	51 (100) (1.8)	0.03*
Diseases of the blood and blood forming organs	18 (38.3) (2.1)	29 (61.7) (1.5)	47 (100) (1.7)	0.34
Mental and behavioral disorders	10 (55.6) (1.2)	8 (44.4) (0.4)	18 (100) (0.6)	0.03*
Other causes**	91 (53.5) (10.5)	79 (46.5) (4.1)	170 (100) (6.1)	NA
Total	864 (31.1) (100)	1912 (68.9) (100)	2776 (100) (100)	

*: Statistically Significant

** :Other causes include diseases of musculoskeletal system and genitourinary system.

NA: Not applicable

Table 3. Trends in underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 (N=2776 deaths)

n (%)	2017	2018	2019	2020	2021	2022	Total	Trend P- value
External causes of death	170(17.1) (36.9)	184 (18.5) (37.0)	158 (15.9) (41.3)	159 (16.0) (35.9)	179 (18.0) (34.8)	142 (14.3) (29.7)	992 (100) (35.7)	0.02*
Diseases of the circulatory/cardiovascular system	105(18.6) (22.8)	101(17.9) (20.3)	65 (11.5) (17.0)	101 (17.9) (22.8)	85 (15.0) (16.5)	108 (19.1) (22.6)	565 (100) (20.4)	0.99
Undetermined causes of death	51 (19.5) (11.1)	39 (14.9) (7.8)	32 (12.2) (8.4)	36 (13.7) (8.1)	46 (17.6) (8.9)	58 (22.1) (12.1)	262 (100) (9.4)	0.61
Neoplasms	46 (18.0) (10.0)	49 (19.1) (9.9)	33 (12.9) (8.6)	32 (12.5) (7.2)	45 (17.6) (8.8)	51 (19.9) (10.7)	256 (100) (9.2)	0.74
Diseases of the nervous system	20 (13.2) (4.3)	28 (18.5) (5.6)	23 (15.2) (6.0)	27 (17.9) (6.1)	32 (21.2) (6.2)	21 (13.9) (4.4)	151 (100) (5.4)	0.99
Diseases of the respiratory system	23 (18.0) (5.0)	27 (21.1) (5.4)	19 (14.8) (5.0)	19 (14.8) (4.3)	14 (10.9) (2.7)	26 (20.3) (5.4)	128 (100) (4.6)	0.77
Infectious and parasitic diseases	8 (11.4) (1.7)	11 (15.7) (2.2)	15 (21.4) (3.9)	13 (18.6) (2.9)	10 (14.3) (1.9)	13 (18.6) (2.7)	70 (100) (2.5)	0.38
Diseases of the digestive system	9 (13.6) (2.0)	15 (22.7) (3.0)	6 (9.1) (1.6)	11 (16.7) (2.5)	13 (19.7) (2.5)	12 (18.2) (2.5)	66 (100) (2.4)	0.66
Endocrine, nutritional and metabolic diseases	6 (11.8) (1.3)	3 (5.9) (1.6)	6 (11.8) (2.1)	7 (13.7) (1.8)	18 (35.3) (1.8)	11 (21.6) (1.7)	51 (100) (1.7)	0.32
Diseases of the blood and blood forming organs	6 (12.8) (1.3)	8 (17.0) (1.6)	8 (17.0) (2.1)	8 (17.0) (1.8)	9 (19.1) (1.8)	8 (17.0) (1.7)	47 (100) (1.7)	0.78
Mental and behavioral disorders	3 (16.7) (0.7)	7 (38.9) (1.4)	3 (16.7) (0.8)	2 (11.1) (0.5)	2 (11.1) (0.4)	1 (5.6) (0.2)	18 (100) (0.6)	0.36
Other causes**	14 (8.2) (3.0)	25 (14.7) (5.0)	15 (8.8) (3.9)	28 (16.5) (6.3)	61 (35.9) (11.9)	27 (15.9) (5.6)	170 (100) (6.1)	NA
Total	461(16.6) (100)	497 (17.9) (100)	383 (13.8) (100)	443 (16.0) (100)	514 (18.5) (100)	478 (17.2) (100)	2776 (100) (100)	
Mean percentage of deaths expected per year=16.7% (SD=1.7)								

*: Statistically Significant

**Other causes include diseases of musculoskeletal system and genitourinary system.

NA: Not applicable

Table 4. Trends in underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 by age-groups and sex (N=2776 deaths)

n (%)	2017	2018	2019	2020	2021	2022	Total	Trend P-value
10 -14	73 (11.3) (15.8)	110 (17.0) (22.1)	87 (13.5) (22.7)	120 (18.6) (27.1)	117 (18.1) (22.8)	139 (21.5) (29.1)	646 (100) (23.3)	<0.01*
15-19	193 (19.5) (41.9)	173 (17.5) (34.8)	134 (13.5) (35.0)	143 (14.4) (32.3)	180 (18.2) (35.0)	168 (17.0) (35.1)	991 (100) (35.7)	0.03*
20-24	195 (17.1) (42.3)	214 (18.8) (43.1)	162 (14.2) (42.3)	180 (15.8) (40.6)	217 (19.1) (42.2)	171 (15.0) (35.8)	1139 (100) (41.0)	0.04*
Female	141 (16.3) (30.6)	132 (15.3) (26.6)	99 (11.5) (25.8)	155 (17.9) (35.0)	170 (19.7) (33.1)	167 (19.3) (34.9)	864 (100) (31.1)	0.16
Male	320 (16.7) (69.4)	365 (19.1) (73.4)	284 (14.9) (74.2)	288 (15.1) (65.0)	344 (18.0) (66.9)	311 (16.3) (65.1)	1912 (100) (68.9)	
Total	461 (16.6) (100)	497 (17.9) (100)	383 (13.8) (100)	443 (16.0) (100)	514 (18.5) (100)	478 (17.2) (100)	2776 (100) (100)	
Mean percentage of deaths expected per year=16.7% (SD=1.7)								

*: Statistically Significant

Table 5. Trends in the underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 by governorate (N=2652 deaths**)

n (%)	2017	2018	2019	2020	2021	2022	Total	%^	Trend P-value
Mount Lebanon	118 (16.4) (26.8)	137 (19.0) (28.6)	112 (15.5) (30.4)	108 (15.0) (25.5)	127 (17.6) (26.3)	119 (16.5) (26.0)	721 (100) (27.2)	33.2	0.82
South Lebanon	75 (14.0) (17.0)	111 (20.7) (23.2)	78 (14.6) (21.1)	85 (15.9) (20.0)	76 (14.2) (15.7)	110 (20.6) (24.1)	535 (100) (20.2)	18	0.01*
Akkar	64 (19.1) (14.5)	47 (14.0) (9.8)	38 (11.3) (10.3)	40 (11.9) (9.4)	77 (23.0) (15.9)	69 (20.6) (15.1)	335 (100) (12.6)	7.8	0.85
North Lebanon	57 (18.3) (13.0)	66 (21.2) (13.8)	42 (13.5) (11.4)	43 (13.8) (10.1)	54 (17.4) (11.2)	49 (15.8) (10.7)	311 (100) (11.7)	14.6	0.30
Northern Bekaa	46 (16.6) (10.5)	35 (12.6) (7.3)	34 (12.3) (9.2)	59 (21.3) (13.9)	47 (17.0) (9.7)	56 (20.2) (12.3)	277 (100) (10.4)	8.4	0.40
Central Bekaa	44 (17.7) (10.0)	44 (17.7) (9.2)	34 (13.7) (9.2)	38 (15.3) (9.0)	63 (25.4) (13.0)	25 (10.1) (5.5)	248 (100) (9.4)	10	0.01*
Beirut	36 (16.0) (8.2)	39 (17.3) (8.1)	31 (13.8) (8.4)	51 (22.7) (12.0)	39 (17.3) (8.1)	29 (12.9) (6.3)	225 (100) (8.5)	8	0.30
Total	440 (16.6) (100)	479 (18.1) (100)	369 (13.9) (100)	424 (16.0) (100)	483 (18.2) (100)	457 (17.2) (100)	2652 (100) (100)	100	

*: Statistically Significant

** : Deaths reported with missing regions were not included in the analysis (4.5%)

^This is the relative proportion of each region within the total population of Lebanon [21]

Table 6. Underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 by governorate (N=2652 deaths**)

n (%)	Beirut	Mount Lebanon	South Lebanon	North Lebanon	Akkar	Northern Bekaa	Central Bekaa	Total
External causes of death	75 (8.0) (33.3)	247 (26.2) (34.3)	173 (18.3) (32.3)	127 (13.5) (40.8)	121 (12.8) (36.1)	113 (12.0) (40.8)	87 (9.2) (35.1)	943 (100) (35.6)
Diseases of the circulatory/cardiovascular system	38 (7.2) (16.9)	144 (27.2) (20.0)	108 (20.4) (20.2)	57 (10.8) (18.3)	54 (10.2) (16.1)	66 (12.5) (23.8)	62 (11.7) (25.0)	529 (100) (19.9)
Undetermined causes of death	21 (8.3) (9.3)	72 (28.3) (10.0)	65 (25.6) (12.1)	27 (10.6) (8.7)	24 (9.4) (7.2)	18 (7.1) (6.5)	27 (10.6) (10.9)	254 (100) (9.6)
Neoplasms	32 (13.0) (14.2)	79 (32.0) (11.0)	52 (21.1) (9.7)	22 (8.9) (7.1)	27 (10.9) (8.1)	17 (6.9) (6.1)	18 (7.3) (7.3)	247 (100) (9.3)
Diseases of the nervous system	8 (5.4) (3.6)	43 (29.3) (6.0)	42 (28.6) (7.9)	16 (10.9) (5.1)	17 (11.6) (5.1)	12 (8.2) (4.3)	9 (6.1) (3.6)	147 (100) (5.5)
Diseases of the respiratory system	6 (4.8) (2.7)	30 (24.2) (4.2)	23 (18.5) (4.3)	17 (13.7) (5.5)	20 (16.1) (6.0)	17 (13.7) (6.1)	11 (8.9) (4.4)	124 (100) (4.7)
Infectious and Parasitic Diseases	10 (14.9) (4.4)	21 (31.3) (2.9)	10 (14.9) (1.9)	13 (19.4) (4.2)	8 (11.9) (2.4)	1 (1.5) (0.4)	4 (6.0) (1.6)	67 (100) (2.5)
Diseases of the digestive system	13 (20.3) (5.8)	13 (20.3) (1.8)	7 (10.9) (1.3)	5 (7.8) (1.6)	16 (25.0) (4.8)	4 (6.3) (1.4)	6 (9.4) (2.4)	64 (100) (2.4)
Endocrine, nutritional and metabolic diseases	2 (3.9) (0.9)	14 (27.5) (1.9)	8 (15.7) (1.5)	10 (19.6) (3.2)	8 (15.7) (2.4)	5 (9.8) (1.8)	4 (7.8) (1.6)	51 (100) (1.9)
Diseases of the blood and blood forming organs	2 (4.4) (0.9)	11 (24.4) (1.5)	14 (31.1) (2.6)	3 (6.7) (1.0)	6 (13.3) (1.8)	3 (6.7) (1.1)	6 (13.3) (2.4)	45 (100) (1.7)
Mental and behavioral disorders	3 (16.7) (1.3)	5 (27.8) (0.7)	1 (5.6) (0.2)	1 (5.6) (0.3)	4 (22.2) (1.2)	1 (5.6) (0.4)	3 (16.7) (1.2)	18 (100) (0.7)
Other causes[^]	15 (9.2) (6.7)	42 (25.8) (5.8)	32 (19.6) (6.0)	13 (8.0) (4.2)	30 (18.4) (9.0)	20 (12.3) (7.2)	11 (6.7) (4.4)	163 (100) (6.1)
Total	225 (8.5) (100)	721 (27.2) (100)	535 (20.2) (100)	311 (11.7) (100)	335 (12.6) (100)	277 (10.4) (100)	248 (9.4) (100)	2652 (100) (100)

** : Deaths reported with missing regions were not included in the analysis (4.5%)

[^]Other causes include diseases of musculoskeletal system and genitourinary system.

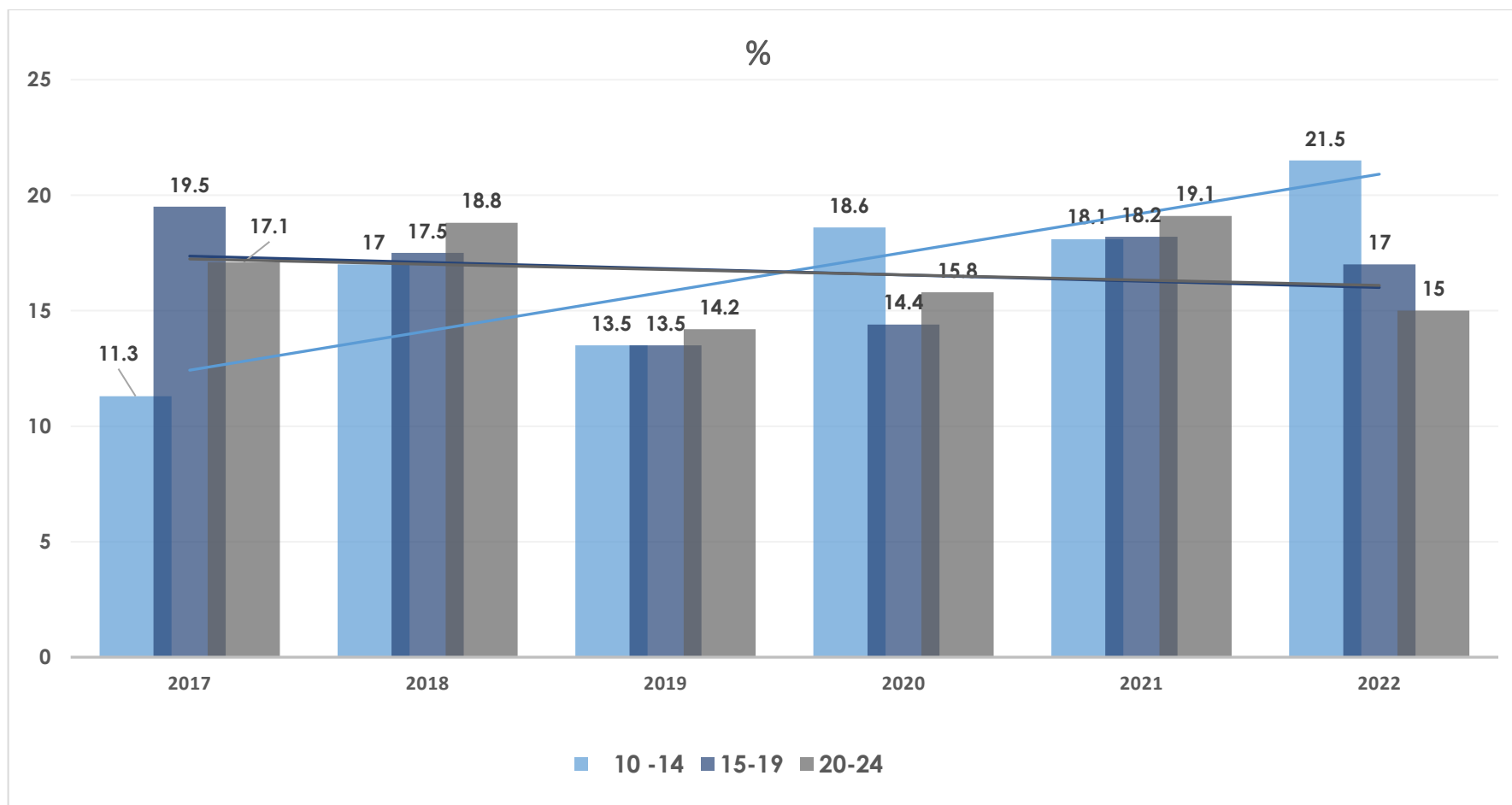


Figure 1. Trends in underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 by age groups (N=2776 deaths)

Trend P-value for [10-14] age group = <math><0.01^*</math> Trend P-value for [15-19] age-group = 0.03^* Trend P-value for [20-24] age-group = 0.04^*

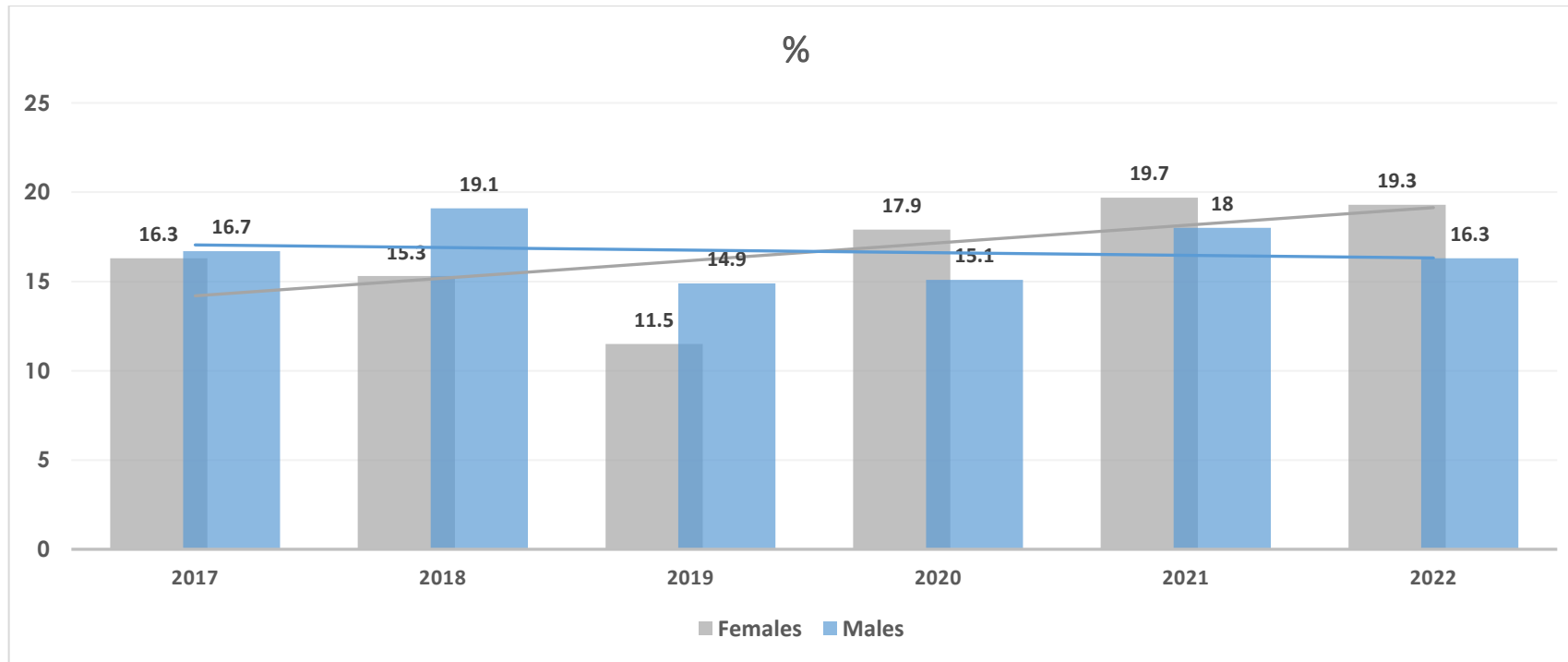


Figure 2. Trends in underlying causes of death (UCOD) among adolescents and young adults in Lebanon between 2017 and 2022 by sex (N=2776 deaths)

Trend P-value = 0.165

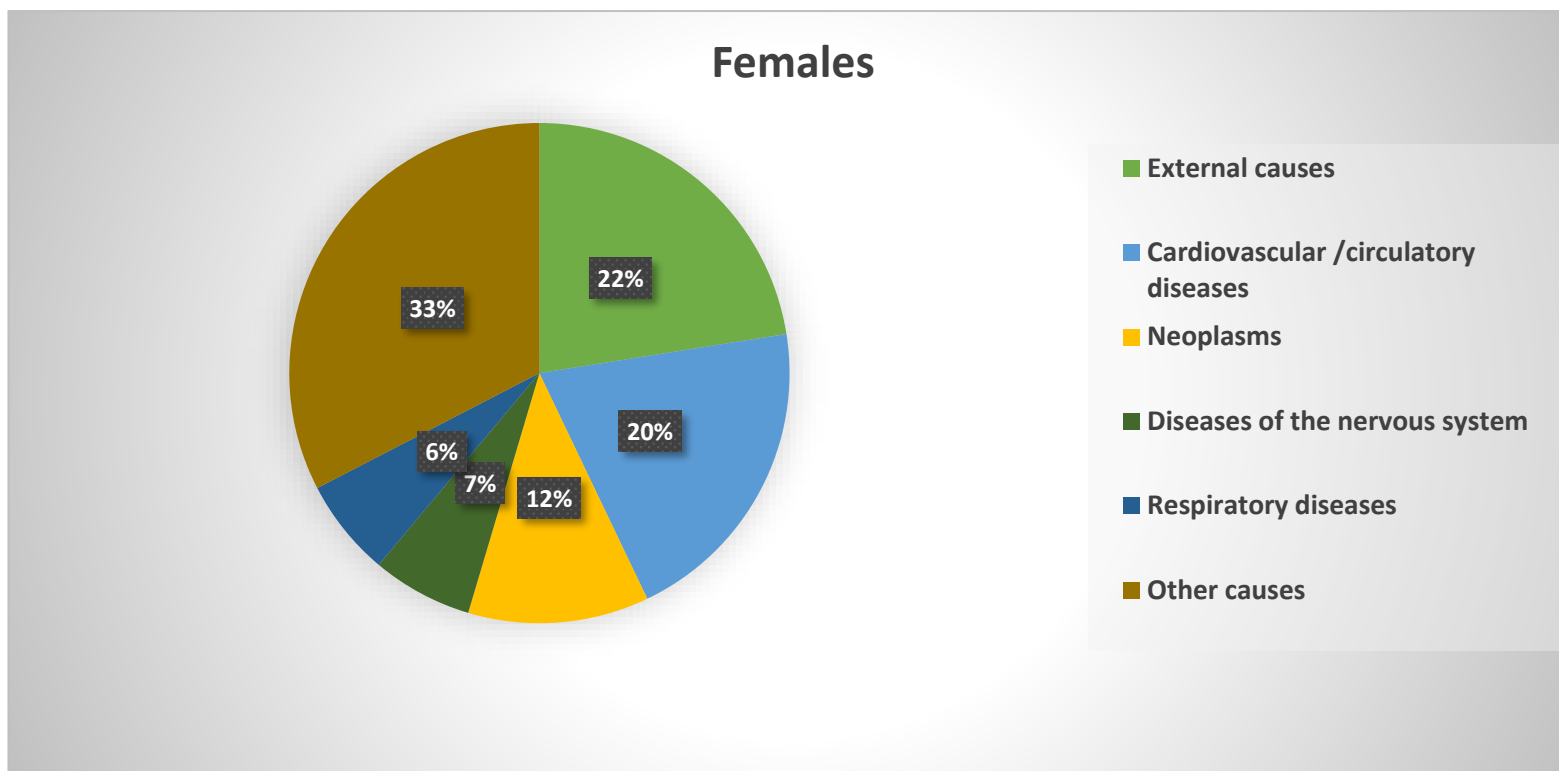


Figure 3. Top five causes of death (COD) among female adolescents and young adults in Lebanon

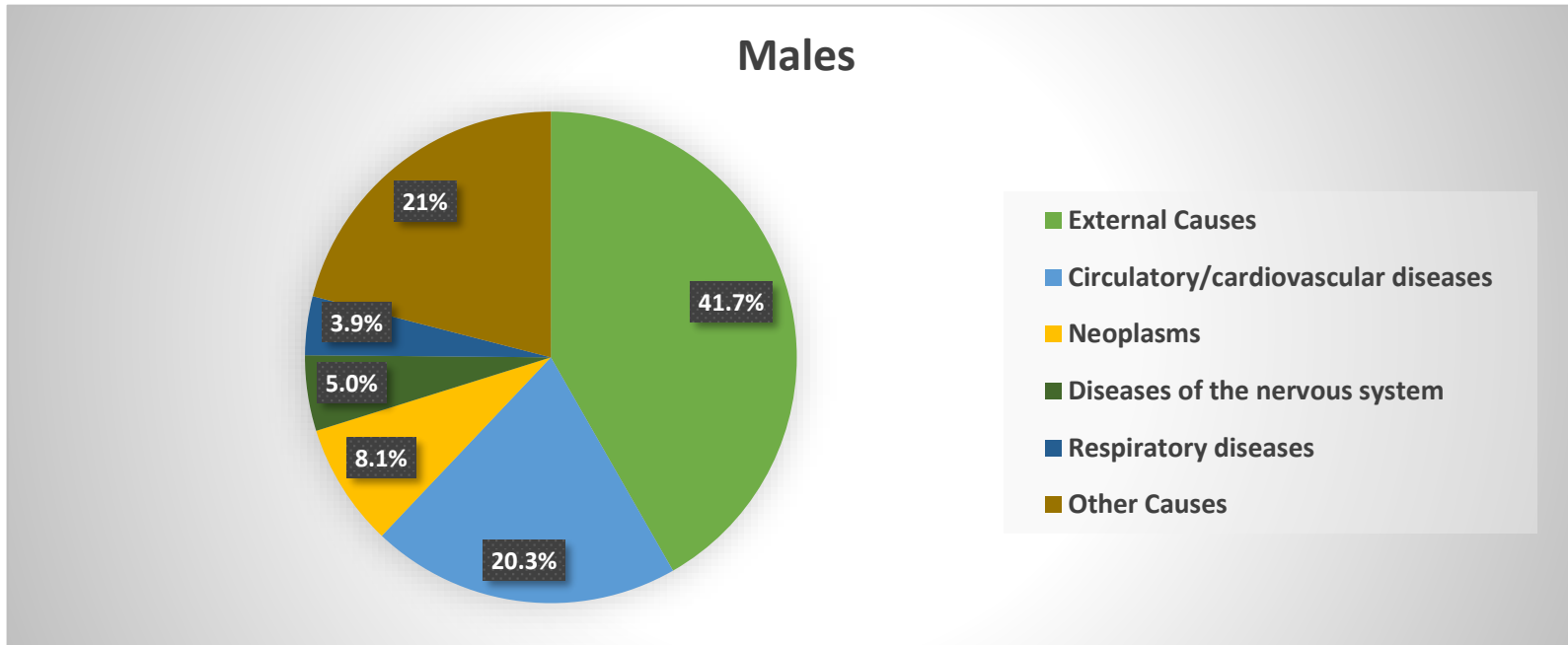


Figure 4. Top five causes of death (COD) among male adolescents and young adults in Lebanon

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