



Insight into the Occurrence of Common Non-communicable Diseases at a Population Level and the Potential Impact During the Coronavirus Pandemic — a Need for a Syndemic Healthcare Approach?

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Abstract

People suffering from non-communicable diseases (NCDs) are at an increased risk for severe Covid-19. The aim was to determine the burden of common NCDs at a population level, assess Covid-19 impact while exploring whether a syndemic approach is merited to deal with NCDs and Covid-19.

Baseline data from a Malta national representative survey. Individuals with type 2 diabetes (T2DM), hypertension, cardiovascular disease, dyslipidaemia and overweight-obese status were considered. Prevalence for single disease and multimorbidity were used to estimate population burden. Covid-19 impact at a population level was estimated through local Covid-19 infectivity rates. Years of life lost (YLL) and mortality rate were calculated using Covid-19 data and compared to corresponding NCDs data reported by global burden of disease (GBD) study.

Half the study population ($n = 3947$) had a single NCD while a third had multimorbidity. Of these, 6.55% were estimated to be at risk of Covid-19 and require admission. Covid-19 YLL over 12 months was 5228.54 years, which is higher than the estimated YLL for hypertension and T2DM by GBD study for Malta.

Health systems and policies should be re-focused to accommodate both Covid-19 and NCDs simultaneously through a targeted syndemic approach with primary healthcare playing a central role.

Keywords Non communicable diseases · Coronavirus · Multimorbidity · Syndemic · Malta

Introduction

Non-communicable diseases (NCDs) have been reported to contribute towards a substantial population burden with increased morbidity and mortality, way before the Covid-19 pandemic existed [1, 2]. The year 2020 saw the emergence of the novel coronavirus SARS-CoV2 that spread across the world leading to high morbidity and mortality rates due to Covid-19 disease, especially among those with underlying NCDs [3]. Governments along with Public Health officials instituted a number of measures including

lockdowns across regions and countries to try to curb the viral spread. However, this led to cancellations of medical consultations and disturbances in the normal healthcare system proceedings. This also exacerbated increasingly sedentary lifestyles and an obesogenic environment [3, 4]. The long-term implications of such actions are yet to be revealed; however, it is predicted that inequalities in NCD burden are on the rise [5]. The people suffering from NCDs are at an increased risk of disability, morbidity and mortality, both from acquiring Covid-19 but also from the disruption in their lifestyle and disease management [6–8]. Therefore, understanding the occurrences of common NCDs at a population level is essential to ascertain that preventive and management action plans and policies are adequately targeting this population. This holds now even more than ever while the Covid-19 pandemic is still ongoing.

Malta is a European small state composed of two main islands situated in the middle of the Mediterranean Sea, with a total population of 493,559 and a total surface area

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of 316 km², making it an ideal candidate for population analyses [9]. These islands share population characteristics of both the Northern and Southern countries including a shift to a more Westernized lifestyle [10, 11]. Additionally, Malta is a known cardiometabolic-obesogenic country with the highest mortality attributed to cardiovascular diseases [12–15]. Like the rest of Europe, Malta reported its first Covid-19 cases in March, and has since experienced several waves [16, 17]. Therefore, this population provides a unique opportunity to explore the impact of Covid-19 on the population suffering from NCDs, namely cardiometabolic diseases. The aim of this study was to determine the burden of common NCDs at a population level and explore their potential impact during the coronavirus (SARS-CoV2) pandemic. The objective was to explore whether a syndemic approach is required to deal with both Covid-19 and NCDs especially in a high-NCD prevalent country. Considering Malta's population characteristics, this study's findings are relevant to both a national and international levels.

Methods

Data set

The study population investigated in this study originated from a cross-sectional health examination survey that represented the adult population of Malta [18]. Briefly, a randomized single stage stratified sampling technique was followed to select the sample population from a national register to represent 1% of the population by age (18 to 70 years), gender and place of residence. All individuals living in Malta for at least 6 months and holding a permanent identification permit were eligible. However, those individuals who were pregnant, too ill to attend the health examination hubs or living abroad at the time of the study were excluded. Participants were invited to take part in an interviewer-led validated questionnaire covering demographic, socio-economic, behavioural lifestyles, medical history and medication, a detailed account of the survey can be found elsewhere [18]. This was followed by a health examination measurement for blood pressure, body mass index (BMI), waist circumference and blood testing for fasting blood glucose and lipid profile.

The Research Ethics Committee of the Faculty of Medicine and Surgery at the University of Malta (ref:19/2014) together with the Information and Data protection commissioner gave their permission for this study. All participants gave their informed written consent to participate in the study.

Definitions

As part of the health examination survey's validated questionnaire, the medical history section, recorded the participant's history for myocardial infarction, coronary heart disease, hypertension, dyslipidaemia and diabetes. Participants were also instructed to either bring the medications packages or a written list of their medications when attending for the survey. Interviewers took note of their medications. For the purpose of this study, participants with a history of myocardial infarction (MI) or coronary heart disease (CHD) were considered as suffering from cardiovascular disease (CVD). During data analyses, CVD was taken as representing the presence of one or both diseases (MI and CHD).

Hypertension was defined as the presence of either self-reported history, or on anti-hypertensive agents or scoring an average systolic of $> = 140$ mmHg or an average diastolic of $> = 90$ mmHg as part of the examination survey. Participants with a history of type 2 diabetes mellitus (T2DM), on oral hypoglycaemic agents or scoring an FBG above 7 mmol/L were labelled as T2DM. Dyslipidaemia was considered as the presence of the combination of an elevated LDL-C, triglycerides and low HDL-C or those on lipid lowering medication without any other underlying condition. Participants with an examined BMI of $> = 30$ kg/m² were labelled as obese, while overweight was defined as a BMI between 25 and 29.9 kg/m² [19].

Analyses

Based on the literature, the common occurring non-communicable diseases (NCD) in Malta were cardio-metabolic diseases i.e., type 2 diabetes, overweight-obesity, CVD (MI and/or CHD), hypertension and dyslipidaemia [15, 20–23]. Hence, it was considered appropriate to consider only these NCDs for this study's analyses. The study population was stratified according to whether participants had a single common NCD or multiple concurrent chronic diseases (multimorbidity). The prevalence for each single NCD and multimorbidity was estimated and stratified by age groups (age-standardized rates) and gender. The occurrences of single NCDs and multimorbidity at a population level were estimated by multiplying the prevalence for each occurrence by age and gender with the Maltese population demographics statistics, as reported by the National Statistics Office (NSO) of Malta [24]. The Chi square statistical test was used to compare categorical variables.

Burden of Covid-19 among the population with NCDs

To predict the infectivity of Covid-19 among the population with NCDs that required admission to hospital, at a

population level, the prevalence rates reported by a nationwide study conducted by Micallef et al. within the only state hospital in Malta during the first Covid-19 wave was utilized [25]. This study reported that 12.4% of Covid-19 admissions had diabetes, 14.6% had cardiovascular disease (CVD) and 20.2% had multimorbidity [25]. Hence, for this analysis, the study's population with NCDs had to be grouped into 3 sub-cohorts, (i) those with diabetes, (ii) those with CVD and (iii) those with multimorbidity (i.e., any combination of 2 or more of the 5 investigated NCDs). Assumptions were made that the prevalence of Covid-19 admissions to hospital as reported by Micallef et al. [25] was consistent throughout the pandemic and reflected the adult population with NCDs.

The “Years of Life Lost” (YLL) is a population metric used to estimate the burden of a disease due to premature death [26]. The YLL metric is calculated by identifying the number of deaths in an age group and multiplying it by a standard life expectancy for that age group, for more details refer to the supplement material. The Institute for Health Metrics and Evaluation (IHME) life expectancy age groups tables was used for this analysis [27]. The mortality cases by age groups were obtained from the Malta Covid-19 dashboard [28]. Based on local news and international literature, most Covid-19 victims, in Malta and elsewhere, had underlying chronic diseases [29, 30]. Therefore, the YLL measure was considered as an appropriate indicator for the burden of Covid-19 among the population suffering from NCDs. Comparisons were made between the Covid-19 YLL and the corresponding mortality per 100,000 population (over 12 months period) to other NCDs (CVD, Hypertension and

type 2 diabetes) YLLs and mortality per 100,000 population, as reported by the Global Burden of Disease Study (GBD) for Malta (2019) [31]. Of note, only the YLL and mortality per 100,000 for CVD, hypertension and type 2 diabetes were provided by the GBD study for Malta.

Results

A total study population of 3947 adults (47.15% response rate) representing approximately 1% of the total population of Malta, was investigated. The average age for the male population ($n = 1988$) was 44.72 years (SD: 15) while that of the female population ($n = 1949$) was 44.96 years (SD 15).

Half of the study's population was observed to suffer from a single chronic disease, with the commonest NCD being an overweight BMI status, as shown in Fig. 1. Of note, hypertension was only observed in conjunction with other disease/s and not as a single chronic disease occurrence. Indeed, a total of 1256 adults (31.82% CI 95% 30.39–33.29) were diagnosed with hypertension, out of which 56.29% had another chronic disease; 25.56% had two other chronic diseases; 8.04% had three other chronic diseases; 8.84% had four other chronic disease and 1.27% had five other chronic diseases. In fact, out of the multimorbidity cohort ($n = 1303$), only 3.45% (CI 95%: 2.58–4.60) did not have hypertension as one of their co-morbid diseases. Table 1 illustrates the occurrence of NCDs as a single disease and as part of multimorbidity at a population level, stratified by age groups and gender. Out of the study's population,

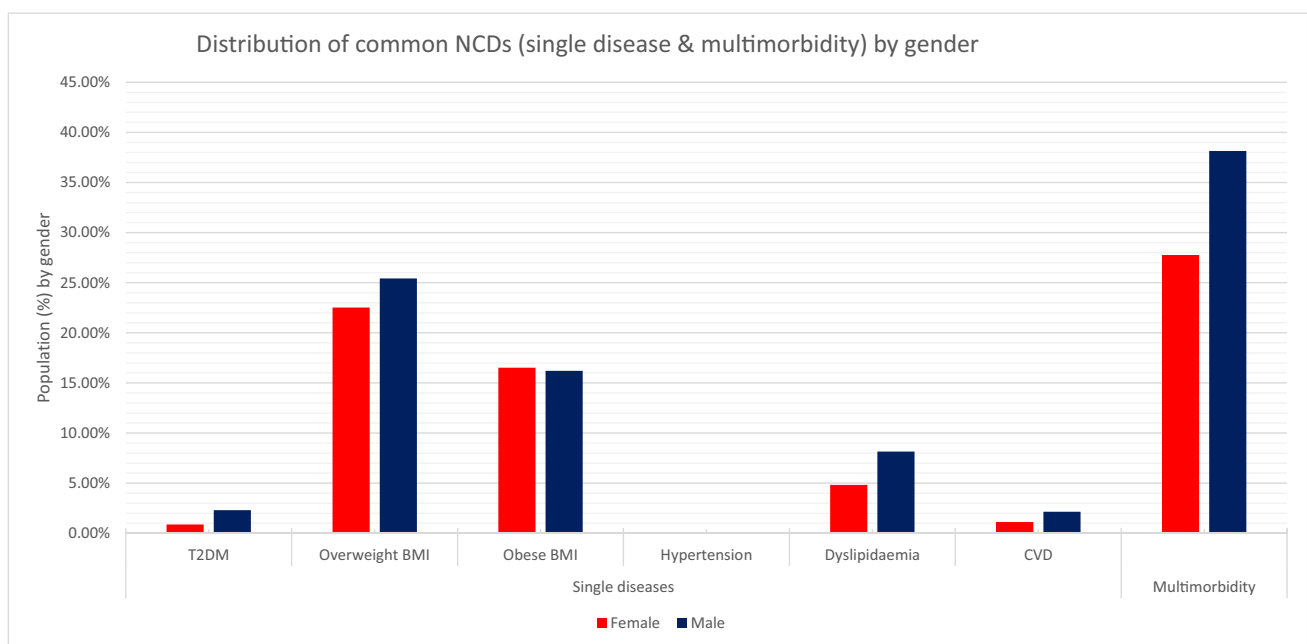


Fig. 1 Distribution of common NCDs as single diseases and multimorbidity among the study population stratified by gender

43.89% (CI 95% 39.54–47.24) represented the working age groups (18 to 64 years) and had one or more comorbidities ($p=0.01$). At a population level, approximately 76,000 males (18–64 years) are predicted to suffer from a single disease, while 47,000 with multimorbidity. Similarly, 62,000 females (18–64 years) are predicted to suffer from a single disease, while 29,000 with multimorbidity.

Impact of coronavirus among population with NCDs

It was estimated that 6.55% of the total Maltese population (18–70 years) suffering from a NCD is at risk of acquiring Covid-19 and consequently require admission to hospital for further management, as shown in Table 2. Those with multimorbidity had a higher admission probability if infected by Covid-19.

A total of 331 deaths (204 Males; 125 Females) were reported between 7th March 2020 and 7th March 2021 ranging from 40 to 99 years of age [28]. The years of life lost (YLL) was calculated to be 5228.54 years. On comparing the Covid-19 YLLs and mortality per 100,000 to those of cardiovascular disease, hypertension, and type 2 diabetes, it

Table 2 Estimated Maltese population at risk of Covid-19 infection and requiring admission to hospital among NCD population

	Diabetes	CVD	Multimorbidity	Total
Population* (N=)	4680	1142	97,922	
COVID-19 admission rate	12.40%	14.60%	20.20%	
Population at risk	580	167	19,780	20,527

*Population between 18 and 70 years

Total Maltese population between 18 and 70 years is 313,166

was observed that Covid-19 had a much higher contributing YLL and mortality rate among the Maltese population than hypertension and type 2 diabetes, as shown in Table 3.

Discussion

Non-communicable diseases (NCDs) are a major global challenge to public health and healthcare systems alike, to provide appropriate and efficient population care. The

Table 1 Distribution of the NCDs burden at a population level by age groups and gender

	Age groups	Single disease					Multimorbidity
		T2DM	Overweight BMI	Obese BMI	Dyslipidaemia	CVD	
Female	< = 19	0	797	399	0	0	0
	20–24	0	2299	1690	270	0	947
	25–29	463	3522	3336	1112	0	1112
	30–34	0	4748	2724	0	234	1168
	35–39	0	3873	2641	176	0	1496
	40–44	269	4301	1792	448	90	1882
	45–49	0	3967	2550	567	71	2975
	50–54	258	3288	2450	967	0	3933
	55–59	79	3228	2598	1024	0	7795
	60–64	0	2197	2727	530	0	8106
Male	65–69	327	2535	1963	2045	0	9242
	70	0	119	317	198	79	1505
	< = 19	0	0	2,113	0	0	423
	20–24	0	2434	504	420	0	1595
	25–29	0	5503	2935	0	0	4311
	30–34	0	6526	4213	1404	0	1900
	35–39	181	5421	3975	1175	0	4427
	40–44	72	5040	4176	1656	0	4464
	45–49	588	4285	2100	1008	0	4705
	50–54	440	2493	2859	1100	220	6818
Total	55–59	556	4102	1391	1877	0	8343
	60–64	398	2229	876	1592	0	9872
	65–69	907	2266	1662	1738	378	9519
	70	142	213	0	320	71	1385
			4680	75,387	51,992	19,626	1142

*CVD represented a history for either myocardial infarction or coronary heart disease

Table 3 Comparisons between mortality per 100,000 and years of life lost (YLLs) of Covid-19, cardiovascular disease, hypertension, and type 2 diabetes

Mortality causes	Mortality per 100,000	YLLs
COVID-19	64.33	5228.54
Cardiovascular disease	209.45	12,998.26
Hypertension	11.74	623.23
Type 2 diabetes	27.14	1776.37

YLLs, Years of Life Lost (over a year)

Mortality per 100,000 and YLLs based on Global Burden of Disease Study 2019 (excl. COVID-19)

burden on hospital admissions and outpatient consultations is heightened by the presence of multiple concurrent NCDs (multimorbidity), now even more so with the ongoing COVID-19 pandemic [32, 33]. Hence, the identification and acknowledgement of the most common NCDs at a regional or country level, according to age and gender is vital for targeted strategic planning and management plans. As is the understanding of the potential effect of Covid-19 on the population suffering from NCDs.

The presence of a single chronic disease or multimorbidity from a young age, as identified in this study, is a public health concern. Such young age occurrences would inevitably decrease the quality of life along the life course of the affected individuals as well as increase the burden on the healthcare system and the disability adjusted life years (DALYs) [34, 35]. It has been reported that those suffering from NCDs have an increased susceptibility to severe Covid-19 [3].

A substantial proportion of the Maltese population, as established in this study, are at increased risk of this syndemic effect. Syndemic refers to the synergistic effect that is produced when two or more epidemics concur together, in this case common NCDs and Covid-19, and the effect that these have on the quality of life, burden and prognosis for the diseases [36]. Indeed, this predilection could affect a proportion of the working-age population, as noted in this study. Consequently, this can lead to a substantial impact on the economic productivity, increased hospitalization with possible admission to the intensive care unit [37]. Although this study estimated that less than a tenth of the Maltese population with NCDs are at risk of acquiring Covid-19 and requiring hospitalization, it is important to note that the hospitalization prevalence data was extracted from a study conducted during the first Covid-19 wave in Malta [25]. During this period, the Covid-19 situation was well controlled, with low daily case numbers. The same cannot be said for the second wave [16, 17]. Hence, it is assumed that the proportion of the population with NCDs

at risk of Covid-19 along with their corresponding burden is much higher than that estimated in this study.

Indeed, the mortality rate and YLLs over 12 months (first wave and second wave included) illustrates the high burden that Covid-19 has on the adult population of Malta. Even considering that Malta has a high prevalence of diabetes and hypertension, Covid-19 manifested a higher mortality and YLL's in comparison to both (over a year). This brings forward an urgent appeal for a syndemic action (to be discussed below). One needs to appreciate that Covid-19 mortality was principally among those already suffering from underlying chronic diseases [29, 30]. Hence, the high Covid-19 mortality rate and consequently high YLLs might be a consequence of these underlying comorbidities [38, 39] or resulting from the non-optimal chronic diseases management following the cancellations or postponements of consultation appointments as part of the instituted measures to curb the spread of Covid-19 [40]. This could also be due to a reduction in medical care access due to a decrease in general practitioners' services due to Covid-19 as well as from personal fear of acquiring the disease, resulting in missed appointments or hindrance in seeking medical help. Covid-19 pandemic also contributed to a socioeconomic burden with loss of jobs and salaries, enhancing the possibility of non-adherence to medication due to lack of affordability of medication [41], unless the individual is entitled to free medication.

It is important to note that those individuals with NCDs that survive the Covid-19 infection may have a negative effect on the progression of their pre-existing chronic disease/s and/or suffer from the long Covid-19 syndrome [40, 42]. In which case, these individuals will benefit mostly from a syndemic management approach.

Implications for policy and practice

The ongoing pandemic proved to be a game-changer for health care systems and for prioritization of resources and care, to deal with the acute Covid-19 infection among the population. However, the impact of NCDs among the population remains to be a real threat even amid the pandemic especially as new Covid-19 variants emerge, increasing the transmission and susceptibility among this vulnerable population. Monitoring the burden arising from common NCDs among the population remains a top priority [5]. Indeed, it seems that both CVD and Covid-19 are contributing to the highest-ranking mortality causes among the study population. Hence, in order to ensure health system resilience and universal health coverage, health systems and policies should be adopted and re-focused to accommodate both Covid-19 and NCDs through a syndemic approach.

Primary health care should play a central role in this syndemic approach. The setting up of a robust primary health care service to cater for the population with NCDs

management along with potential long Covid-19 syndrome is the way forward. Although it is early days, the long Covid-19 syndrome might be considered as a ‘new chronic disease’. Indeed, health professionals should be on the alert for the presence of this condition and offer a thorough physical examination and appropriate personalised management including psychological aid [43].

Primary care centres cater for local catchment geographical areas and provide easy accessibility to medical care to the residents. Establishment of chronic diseases clinics in these centres tailored to cater for both epidemics (NCDs and Covid-19) simultaneously will not only enhance the long-term management of the affected population but decrease the workload on tertiary healthcare systems. This in turn, enables a better focused medical care for acute exacerbations of conditions or acutely acquired communicable diseases including acute Covid-19. Primary health care can also play a role in prevention and screening strategies for NCDs especially targeting the young generation. As identified in this study, the young generation is not exempt from suffering from chronic diseases or multimorbidity. Hypertension screening should be part of every consultation including among those already known to suffer from a chronic disease. As was observed in this study, hypertension appears to be part of a multimorbidity profile.

On setting up the syndemic system, a multisectoral approach should be followed. This should not only target direct effects arising from NCDs and Covid-19 but also consider other associated factors. Mental health, food security, physical activity, and wellbeing of the population among other factors have been challenged by the concurrent occurrence of NCDs and Covid-19. Indeed, the pandemic has increased the burden on the mental health of the populations [44]. Hence, it is essential that psychological and social support within the community is enforced to aid the population. The primary healthcare centres make the perfect locations for such services. The pandemic has also challenged food security and access to physical activity sites especially during lockdowns. One may consider subsidies on nutritional value food to encourage adequate nutritional food intake while indirectly aid in the prevention of the development of co-morbidities including type 2 diabetes and obesity. Increasing access to open spaces for physical activity will encourage individuals to engage in any kind of activity as well as indirectly have a positive impact on the mental health status.

Study limitations

The study data was gathered through a cross-sectional study that was conducted between 2014 and 2016. The results presented in this study are assuming that the same phenotypic characteristics are still representative of the Maltese

population. Due to the nature of the study design, temporal relationships could not be assessed for. It is therefore recommended that a longitudinal cohort study is conducted to further evaluate the observations of this current study. Only the most common occurring NCDs (cardiometabolic diseases) in Malta were considered for this study. Other underlying co-morbidities may have been present such as chronic liver disease, cancers, chronic respiratory disease, mental health problems; however, such data was not available. This might have also influenced the study’s outcomes. The presence of type 2 diabetes, overweight, obesity and dyslipidaemia was based on both examination results and self-reported history. However, the presence of cardiovascular disease was based on self-reporting data, hence, subject to self-reported bias. The impact of coronavirus among the population suffering from NCDs was based on the assumption that the admission rate among this population remained the same throughout the Covid-19 period as reported by Micallef et al. [25], even though in reality the Covid-19 situation got worse overtime [17]. Hence, the Covid-19 impact estimated within the population with cardiometabolic NCDs in this current study is expected to be an underestimate of the actual burden. The study’s NCD data had to be grouped together to enable the estimation of Covid-19 impact on the population as well as to compare the Covid-19 YLLs and mortality per 100,000 according to the published literature. This might have limited the study’s outcomes. It needs to be pointed out that some disparity in the outcome might be present as real data of Covid-19 YLLs and mortality was compared to estimated data from the GBD study. Furthermore, the lack of uncertainty intervals led to the inability to produce a dispersion index, which might affect the accuracy of the analyses.

Conclusion

The occurrence of single chronic disease or multimorbidity is common among the Maltese population from a young adult age. A tenth of the Maltese population with NCDs is at risk of acquiring Covid-19 and requiring hospitalization. The Covid-19 mortality rate and the associated YLLs were observed to be higher than those arising from type 2 diabetes and hypertension. A targeted syndemic approach as part of the primary healthcare structure is essential for the simultaneous management of both NCDs and Covid-19. This ensures health system resilience, universal health coverage and decrease population burden.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s42399-021-01064-2>.

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Author contribution SC was responsible for the data collection, data analyses and writing of the article draft. SG contributed to the writing of the article, reviewing, and finalising the article.

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Data and materials availability Data is available upon request.

Code availability IBM SPSS version 21 was used for statistical analyses.

Declarations

Ethics approval and consent to participate Ethics clearance was obtained from the Research Ethics Committee of the Faculty of Medicine and Surgery at the University of Malta (ref:19/2014). Informed written consent was obtained from each participant to take part in the study.

Consent for publication Informed written consent was obtained from each participant to publish anonymous data.

Conflict of interest The authors declare no competing interests.

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