Master of Public Health

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The effects of social protection and labor programs on suicide mortality: a study of 81 low-and-middle-income countries between 2000 and 2019

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This thesis is dedicated to my father. Maite zaitut Gran Aitatxu.

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Glossary of acronyms

HIV	Human Immunodeficiency Virus
ICD-10	10th Edition of the International Classification of Diseases
LMIC	Low-and-Middle-Income Countries
WHO	World Health Organization
SEA	South-East Asia
UN	United Nations
SNG	Sustainable Development Goals
ILO	International Labor Organization
SPL	Social Protection and Labor
LGBTQ+	Lesbian, Gay, Bisexual, Transgender, Queer, and others
SEH	Socioeconomic and Health variables
GDP	Gross Domestic Product
HIC	High Income Countries
GSED	Global Social Epidemiology Dataset
HIA	Health Impact Assessment
ISGlobal	Barcelona Institute for Global Health
GBD	Global Burden of Diseases, Injuries, and Risk Factors
IHME	Institute for Health Metrics and Evaluation
GHE	Global Health Estimates
ICD-9	9th Edition of the International Classification of Diseases
RSE	Robust Standard Errors
ASPIRE	Atlas of Social Protection Indicators of Resilience and Equity
PPP	Purchasing Power Parity
NB	Negative Binomial
IRR	Incidence Rate Ratio
WBDI	World Bank Development Indicators
AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
VIF	Variance Inflation Factor
SD	Standard Deviation

P>|z|	P-value
CI	Confidence Interval
MWI	Malawi
ODA	Official Development Assistance
MMR	Myanmar
TLS	Timor-Leste
VNM	Vietnam
NER	Niger
ZMB	Zambia
L-M	Lower-middle
U-P	Upper-middle

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ABSTRACT (ENGLISH)

Background: Evidence on suicide is mostly based on high income economies. However, more than 77% of total suicide deaths occur in low-and-middle-income countries (LMIC). Social protection and labor (SPL) interventions aim to attenuate the effects of socioeconomic inequalities and poverty. This could influence suicidal behaviors.

Objective: To explore the effects of social protection and labor (SPL) programs on the suicide mortality rates in 81 low and middle-income countries between 2000 and 2019.

Methods: Crude and age-standardized suicide mortality rates were analyzed using Poisson models with fixed-effect regression and robust standard errors. Adjustments by socioeconomic and health factors were made. Data was obtained from the Global Social Epidemiology Dataset (ISGlobal, Spain), which embedded information from IHME-GBD, WHO-GHE and the World Bank. SPL variable was measured using the indicator coverage as defined by ASPIRE. Effects of SPL coverage were tested using data for 81 LMIC across the period 2000-2019.

Results: Findings suggested potential protective effects of SPL programs on reducing the suicide mortality rates of the overall population in 81LMIC for the period 2000-2019. Current health expenditure and depressive disorders were associated with reduced suicide mortality rates in the overall population. Findings in stratified analyses by sex, age, wealth distribution and income level suggested similar protective effects in most categories as for the overall population.

Conclusions: Results from this study suggest that implementing SPL programs could had protective effects against suicide mortality in 81 LMIC between 2000-2019. Understanding the contextual particularities in each country could lead to target efficient social interventions against suicide. Qualitative studies should be considered for this aim. Further studies at the population and individual level are needed in LMIC to strengthen this evidence.

Keywords: Social protection, suicide, low-and-middle-income, health determinants, panel data, fixed-effects

1. INTRODUCTION

1.1. Suicide in context

Every 40 seconds a person takes their own life somewhere in the world. That means more people dying from suicide than from homicide, HIV, malaria, or breast cancer (1). Specifically, more than 700,000 people die due to this cause every year, making suicide the 10th leading cause of death and the 4th leading cause among 15-29 years old in 2019, after road injury, tuberculosis, and interpersonal violence. By 2021, still 1 out of 100 deaths were attributed to this tragic cause, and yet, these numbers represent only the tip of an iceberg (2).

Suicide can be defined as one individual's "intentional ending" of their own life (3), or as reported by the 10th Edition of the International Classification of Diseases (ICD-10) (4), a death caused by "intentional self-harm". Yet, the scope of this global threat goes beyond the individual, as it very often impacts their friends, loved ones, and communities, who may potentially experience thoughts of suicide themselves even long after these tragic events occur (5). Published estimates suggest that rates of suicidal behaviors (attempted-non completed and suicide ideation) are 20 to 30 times higher than those of suicide deaths. Particularly, feelings of hopelessness, isolation, depression or alcohol and drug abuse are well-cited risk factors associated with suicidal behaviors, especially among high income countries (6). However, suicide does not only represent a threat for high income countries. In fact, in 2019, more than 77% of this global burden was estimated to occur in low and middle-income countries (LMIC) (7).

Suicide rates can vary greatly between countries, regions and by sex. Despite the global age-standardized suicide rate average was 9.0 per 100 000 population in 2019, this rate oscillated from less than two deaths by 100 00 for some countries, to over 80 per 100 000 population in the case of the Russian Federation (1). According to the World Health Organization (WHO) region estimates, by the year 2019, Africa (11.2 per 100,000), Europe (10.5 per 100,000) and South-East Asia (SEA) with 10.2 per 100,000 showed the highest global suicide rates, while the Eastern Mediterranean region registered the lowest suicide rate with 6.4 per 100,000 (2). Lastly, by sex, more than twice as many males die due to suicide as females (12.6 per 100,000 males vs 5.4 per 100,000 females) with regions showing very different male-to-female ratio of self-harm rates (1).

1.2. A need for public health action

Since the start of the millennium, the global suicide rates have been somewhat decreasing. Nevertheless, this decline has experienced a deceleration in the last few years and even an increase in areas like the Americas region, which reported a 17%

increased in the suicide rates in the period between 2000 and 2019. (1). A recent declaration by the WHO stated that this serious public health issue could exceed the 1-million-mark mortality rates in the next 15 years (6). Further, different international studies made in high income countries brought to the table the financial aspects and major impact that fighting against suicide represents for the economy of the states, as the peak of suicide rates are greater among the working age population (8, 9). A study conducted in the United States described that, in 2019, the financial burden of suicide deaths and other suicidal behaviors cost the country about 490 billion dollars in medical and other quality life-related costs (10).

As a response to the problem, the prevention of suicide was again highlighted in the last WHO report "Suicide Worldwide" (2019) as a global public mental health problem that needs from immediate action (1). In addition, according to predictions of the United Nations (UN), the Sustainable Development Goals (SDG) agenda of reducing suicide mortality by one third by 2030 (target 3.4) will not be met if the suicide trends continue as currently (11).

1.3. Social protection as driver of change

In 2016 a systematic review of 37 studies was published studying the relationship between poverty and suicidal behaviors in LMIC (7). Understanding this connection is important for suicide prevention, as poverty and income inequalities might be closely linked to suicidal behaviors (12). This association can be especially relevant for the least developed countries where rates of poverty and suicide are high, and the financial costs of suicidal behaviors are important (7,12). However, little attention has been put in exploring a potentially decisive factor, social protection which aims at reducing poverty, and therefore, may also impact on suicide.

As defined by the International Labor Organization (ILO) (13), social protection represents the set of public measures that a society provides for its members to protect them against economic and social distress that would be caused by the absence or a substantial reduction of income from work as a result of various contingencies. Promoting social protection is also part of the UN Sustainable Development Goals (11), as goal 1.3. *calls for the implementation of nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and vulnerable*.

Advances in the study of key factors that act prompting suicidal behaviors continue to be hampered by the lack of accepted models to explain suicidal behaviors (14). Traditionally, the epidemiological research in suicidology has been conducted within a

risk-factor paradigm that prompted many studies describing correlations with suicidal behaviors. However, recent theories have put back the spotlight on what Durkheim already started drawing attention to in his work *Le Suicide* (15), the protective effects income equality and welfare states can have in preventing suicide.

In line with Durkheim's work, two main sociological theories, the "social integration theory" and the "social regulation theory" (17) arise to help us understand better the role social protection systems play against suicide. There are others (3) but in the end, all of them share the same underlying conclusion: intentional self-harm behaviors may burst in as a means to seek resolution during moments of crisis, when one's ability to deal with life stressful circumstances breakdown and the threat of being socially excluded and trapped emerge. Is in these critical scenarios where it becomes crucial the ability of a state to provide their individuals with a social support structure or welfare "safety nets" that allow them to react successfully against these crises and prevent them from feeling trapped and with no other solution but employing suicide (7, 15, 16).

With all the aforementioned, the role of any social protection and labor (SPL) program is to set a range of measures that help mitigating the risks associated with the social environment experienced at any given time by their societies (economic crises, catastrophic health expenditures, marginalization) that could lead individuals to feel with no other choice but attempting suicide (18). Social protection measures materialized in a set of programs that include housing in homelessness or overcrowding situations, pension coverage for the aging and widowed population, income support for maternity care, the disabled and unemployed people. Also, these programs can provide cash transfers and benefits for the more economically deprived, promoting their health and education, while allow them to seek opportunity to lift themselves and their families out of poverty (7, 18).

This reinforces the idea that social protection interventions could impact on reducing suicide, as such interventions may tackle the psychological experiences of poverty and social disintegration, that in the end, can precipitate suicidal behaviors. In fact, suicide rates have been reported to be higher amongst vulnerable groups and those who experience discrimination, such as refugees, migrants, indigenous peoples, LGBTQ+ collective and prisoners (19, 20, 21).

1.4. The paradigm of low-and-middle income countries

The LMIC bear the largest share of the suicide burden, and yet, numbers are presumably still underestimated as national strategies for the prevention, accurate registry and action in these countries continue to be neglected (7).

A growing body of literature have documented the link between suicide and socioeconomic variables, such as poverty, economic crisis, indebtedness, and unemployment which helps explaining why resources and services for the early identification, treatment, and support of people with suicidal behaviors can be limited or non-existent in some of the most deprived countries (7, 9, 10, 12, 17, 22).

According to the World Bank, by the year 2019, the average current health expenditure (% of GDP) for low-and-middle income countries was of 5.33%, while for high income countries (HIC) was of 12.53%. Furthermore, even if governments provide about 51% of a country's health spending in some of these regions, there is still about 35% of health spending per country coming from out-of-pocket expenses, which dramatically impacts the individual's welfare pushing over 100 million people into extreme poverty each year (23).

In addition, many LMIC experience internal civil conflicts, geographical barriers, and even a cultural taboo or stigma, as suicide continues to be illegal in some communities and cults (5). This last fact, add another question to the problem as even if help is provided by the states, it might still be hard for some individuals experiencing suicidal ideation to seek and reach others for aid.

Overall, social protection systems are meant to mitigate the socioeconomic and contextual factors that can prompt individuals to experience intentional self-harm behaviors, which can be especially relevant in LMIC (3, 11). Nevertheless, all papers published to date have their focus set on studying this relationship in high income countries while none explore quantitatively the effects of social protection in LMIC (3). This exposes a gap in the literature that needs to be addressed.

"Reducing the global suicide mortality rate by one third by 2030", is also the only target for mental health in the WHO's Comprehensive Mental Health Action Plan 2013– 2030 (24). In addition, WHO's 13th General Program of Work 2019–2023 (25), includes the same indicator with a reduction target of 15% by 2023.

The urge to investigate this association between social protection and suicide in low-and-middle income economies is not only driven by the fact that most of the total suicide burden is born by LMIC, but also, because of the potential impact social protection could

have in preventing suicide if timely, evidence-based, and efficient interventions were implemented for this purpose (1, 3, 6).

1.5. Research aim

This study hopes to help improving knowledge of to what extent social protection interventions can influence on the suicide mortality in LMIC, where studies of this type are currently scarce and very much needed. Being a study at the country level, one of the strengths of this investigation will rely in its external validity as social protection and labor (SPL) programs are examined in a quite representative sample of 81 low-and-middle income countries (out of the total 140 LMIC) as classified by the World Bank in 2000, the starting year of our 20-year follow-up period.

1.6. Objectives

The main objective of the study is to explore the effects of social protection and labor programs on the suicide mortality rates in 81 low- and middle-income countries between 2000 and 2019. In order to achieve this goal, we decided to establish two more specific objectives:

- To study across time the main association between SPL programs and suicide mortality rates in the study population, crude and adjusted by several socio-economic and health (SEH) variables.
- To explore the adjusted effects (by SEH variables) across time of SPL programs on the suicide mortality rates of the study population overall, by sex, by age, by welfare distribution quintiles, and stratifying the population by country-income levels.

2. MATERIALS AND METHODS

2.1. Study design

We conducted a longitudinal ecological study following a panel data structure, which combined the analysis of a total 81 countries (low-and-middle income), with a temporal trend design over the 20 years between 2000 and 2019. Therefore, the unit of analysis was the country examining a total of 1,620 country-year observations. Only countries with two year-point observations for both main associated variables were included in the study population The final study population was mostly representing lower-middle-income (n=31) and upper-middle income (n=38) countries, as minimum reliable data for the social protection variable was only possible for 12 low-income countries as we further describe below in Figure 1.

Figure 1. tries to illustrate the overall process of selecting, merging, and cleaning the dataset to obtain the onset study population. For the overall purpose of this investigation, we follow several inclusion criteria. First, we included the largest possible time frame for which data for both the outcome (suicide mortality) and the main predictive variable (SPL programs) was available, which end up being the period between 2000 and 2019. Also, we decided to exclude from the investigation all countries that were classified as “high income” by the World Bank (26), at the onset of study in the year 2000. Furthermore, we decided to drop the countries for which data for suicide mortality rates were not complete for all the 20-years of the study period. In the case of the SPL variable, we had to be more flexible with the inclusion criteria as data for social protection programs was found to be very scarce in LMIC. Therefore, we set a more demanding inclusion threshold of minimum 2 country-year observations for each country for the total period between 2000 and 2019. This final threshold was set after literature review on methodology strategies (27) for analyzing associations in countries for which research can be of great impact, but good-quality data records can be scarce, as in this study where the focus of interest are LMIC.

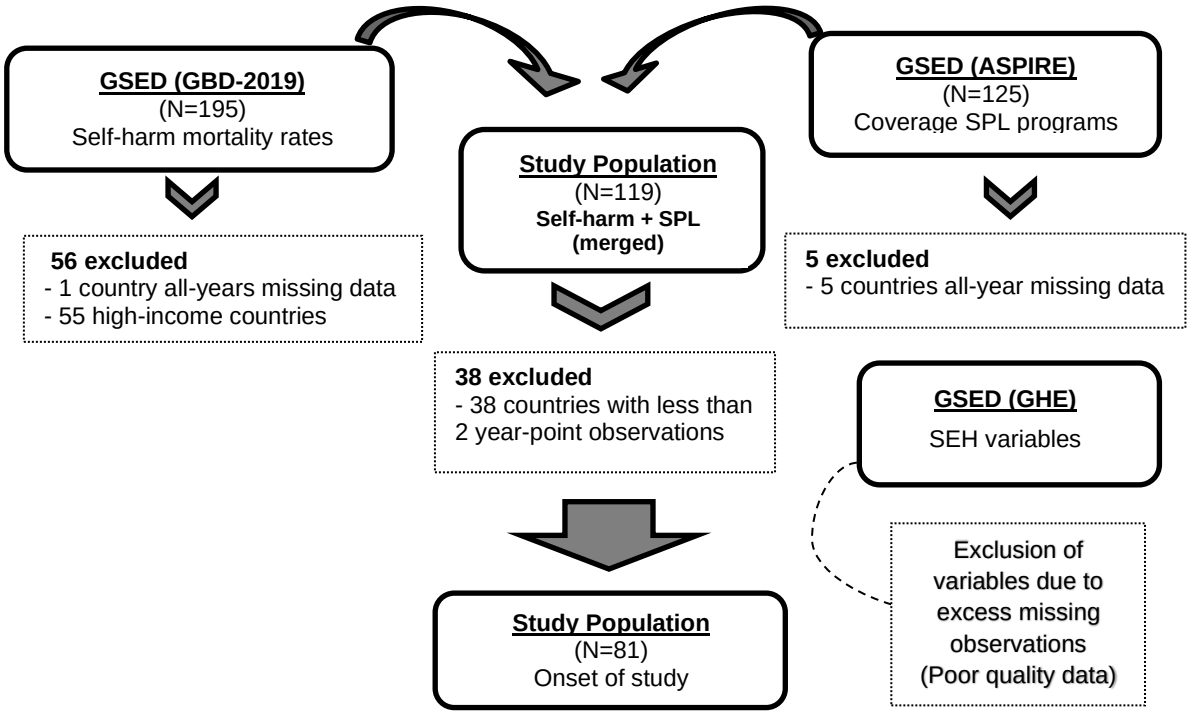


Figure 1. Population selection for the study (N=81)

2.2. Data sources and data collection

To explore the association between social protection and suicide mortality rates, data from the Global Social Epidemiology Dataset (GSED) with information of more than 195

countries in the last four decades was used. The GSED is an initiative created by the Health Impact Assessment (HIA) team of the Barcelona Institute for Global Health (ISGlobal) (28), which compiles and harmonizes a comprehensive set of demographics, socioeconomic and health information from official public and open domain sources. The ultimate goals of the GSED are to contribute improving knowledge about how different policies, programs, and projects may impact the health of a population, and, to evaluate and model more effective interventions for the SNG agenda (11).

The variables extracted from the GSED dataset and used for our study included: the outcome variable, crude and age-standardized self-harm mortality rates (per 100 000 population); the main predictive variable for which we used an aggregate data of all social protection and labor programs measured by the indicator coverage (% of total population covered by any SPL program); finally, we add 7 socioeconomic and health variables originally extracted from the Global Health Estimates (GHE) (29) by WHO, in our analyses according to their potential influence in the main association that will be further described at the end of this section.

For the purposes of our research, information on the outcome “suicide mortality” was examined using the crude and age-standardized self-harm mortality rates (per 100 000 population), overall, by age-group and sex. This information, was originally collected from the Global Burden of Diseases, Injuries, and Risk Factors (GBD) Study 2019 (30), led by the Institute for Health Metrics and Evaluation (IHME), of the University of Washington (31). The GBD-2019 estimates implemented the ICD definition of suicide mortality as death caused by “purposely self-inflicted poisoning or injury” (ICD-10 codes X60-X64.9, X66-X84.9, Y87.0; ICD-9 codes E950-E959) (4). The GBD-2019, gathers 15 937 location-years of vital registration data and 1619 location-years of data for suicide. Our outcome estimation had information registered since 1980, but data for least developed countries was scarce before the mid-1990s (30). Data for intentional self-harm is expressed as an aggregated cause of death and was obtained from verbal autopsy reports (frequently used in locations lacking vital registration systems), and from vital registration systems which are the most reliable and preferred source for obtaining death cause information using the ICD coding systems when possible(3, 12, 30). Comparability of data between countries could be mainly affected by reporting criteria, including the ascertainment of individuals intention of killing themselves, who performed the completion of death certificates, whether a forensic investigation existed or not, and confidentiality criteria towards the cause of death (3). To address this variation in data, the GBD used age-standardized mortality rates (deaths per 100 000 inhabitants) taking the WHO population as the reference to remove differences in age structures across

countries and over time (30). Other methods to ensure data quality include cleaning and organization of inappropriately coded or uncounted causes of death by reassigning whenever possible the best fitting codes using the ICD-10 and ICD-9 (4). Age-standardized suicide mortality rates, overall and by sex (male, female), and crude suicide rates by age group (10-24years, 25-49 years, 50-69 years, 70 years or more) were obtained from the GBD 2019 (30). For the age-specific analysis we included the suicide rates of the overall population aged 10 years or above since this event is very infrequent before this age (1, 3, 12).

For the study of the main exposure variable “social protection”, we used the social protection performance indicator “coverage” as provided by the Atlas of Social Protection Indicators of Resilience and Equity (ASPIRE) (18). ASPIRE is the World Bank’s compilation of indicators that measure the extent and performance of social protection programs (18). The coverage indicator of Social Protection and Labor (SPL) programs, estimate the performance of different social assistance, social insurance, and labor market programs in 125 countries based on nationally representative household surveys. This indicator also refers to the percentage of population participating in social protection and labor programs, including direct and indirect beneficiaries, and for the aim of this study we used the overall SPL program s’ annual coverage measurements for the entire population and by quintile of pre-transfer welfare distribution (18, 32). Due to the nature of this research, the SPL coverage for the “extreme poor” population (those living with less than 1.9 dollars per day) which is usually included in the first quintile of welfare distribution was extracted as a different category for its separate analysis.

To sort the problem of unbalanced panel dataset resulting from this lack of country-year observations, we decided to implement linear interpolation and extrapolation strategies to complete the missing data described for the SPL programs variable (33). Interpolation was used to estimate a possible sequence of observations in between the minimum of 2 data points we established as a threshold, whereas with extrapolation, we determined the remain outside unknown values based on the curve tendency described by the observations points we already have. After interpolation and extrapolation was made, we checked for completeness of data and decided to standardize the coverage SPL variable, overall and by quintiles of poverty level, fixing limits from 0 to 100 to make the comparison and interpretation of results easier (27, 33).

Lastly, we used several criteria to select some contextual (SEH variables) factors that may influence the association between SPL programs and the suicide mortality rates.

Covariates were obtained from the Institute of Health Metrics and Evaluation (IHME) (31), the World Bank data (26), and the estimates from the WHO-GHE (29). For example, we only included those SEH variables with the least missing observations (less than 10%) for our population and period of study. As represented in *Figure 1.* we had to exclude some possibly influential factors like sexual violence (% all ages), undernourishment (% of total population), or universal-health-coverage service index, due to scarce data availability. Nevertheless, we managed to find good quality data, and complete the gaps with interpolation techniques previously described, for other 7 relevant covariates: depressive disorders (% all ages), interpersonal violence (% all ages), age dependency ratio (% of working-age population), health expenditure (% of current GDP), unemployment (% of total labor force), adult literacy rate (% of people 15 ages and above) and Gini Index (1, 2, 6, 12).

2.3. Statistical methods

Statistical analyses were operated by using STATA/BE 17.0 (StataCorp LLC) for Windows11 64-bit version (34). Panel regression models were used to estimate the crude and adjusted association between suicide mortality rates (overall and by sex and age) and coverage of SPL programs (total population, population by income level, and by welfare distribution quintiles) (33). Below is the statistical analysis plan, containing the details of the chosen statistical methods and the steps followed to build up our panel data model: Below is the statistical analysis plan, containing the details of the chosen statistical methods and the steps followed to build up our panel data model:

1. Summary of the characteristics (number of observations, mean and standard deviation), for the outcome “self-harm mortality” and the main predictive variable “SPL programs” across the 20-year period of study: for the onset year 2000, after 10 years in 2010, and at the end of the follow-up in 2019. Also, we decided to include a description of the percentage mean change of the variables for the total 20-year period. Furthermore, variations from the results of our main analysis were expected to be present in specific subgroups of the population. For this reason, we decided to add in the summary statistics the description of the population grouped according to several factors. Table 1. includes the description of the outcome self-harm mortality overall and grouped by sex, age, and stratified by country income level; whereas Table 2. contains the overall SPL programs description and by quintiles of welfare distribution and the stratification by country income levels. Finally, we display

at the end of Table 2. the description of the selected socioeconomic and health factors included in this study.

2. As the main objective of this study explores the effects of SPL programs on suicide deaths across a time-period of 20 years, we decided to use the fixed-effects model. Fixed-effects models have been used in previous ecological works on suicide (9, 12, 22, 35). The advantages over a random-effects model for our study, is that, fixed-effects model can control for unobserved time-invariant factors correlated with the exposure variable and the outcome of interest at the country-level, and this cannot be controlled otherwise by using random-effects, while the use of random-effects model would not allow us to control for these hidden factors (33).
3. The estimated main regression equation was:
   $Log\ (Yit) = \alpha i + \beta 1 SPLit + \beta Xnit + uit,$
   where Yit refers to the number of suicides divided by the population residing in country i in year t; αi was the fixed effect for country i which captures the unobserved time-invariant factors; SPLit was the Social Protection and Labor program coverage for country i in year t; Xnit the value for each of the co-variables in the model, including all the socio-economic and health factors, in country i in year t; and uit the error term.
4. As we have a reasonable large cross section (81 countries), we could include robust standard errors (RSE) in our regression models clustering by the country group to control for autocorrelation, and for heteroskedasticity in our outcome data (33). In our study, we tested for heteroskedasticity using the Breusch-Pagan/Cook-Weisberg test (33). The null hypothesis of this test assumes a normal distribution with constant variance of our outcome variable suicide mortality. As the null hypothesis was rejected, we assumed heteroskedasticity to be present. One of the reasons to explain heteroskedasticity can be the presence of overdispersion in the outcome data. For the aim of this study, we assumed presence of overdispersion, and as suicide mortality was a count variable, then it could follow a Poisson distribution. However, as overdispersion was assumed, we decided on comparing the Poisson model with the negative binomial (NB) model, a more complex model but that usually controls better for overdispersion (33, 36).
5. We decided on using the Poisson model with an offset variable (for incidence mortality rates) for the purpose of our study, as the NB model presented identical results in the regression analysis and Poisson had a better model fit when verified through AIC and BIC tests (36). Appendix 1. shows the

regression results comparing the Poisson and NB models (adjusted by the SEH variables), and also the results from their goodness of fit comparison.

6. Correlation matrix was carried out, to check for multicollinearity between several covariates that were selected based on previous literature reading (2, 5, 7, 36).
7. To conclude the study, we decide to run some regression analysis using the sex-specific and age-specific suicide mortality rates, the SPL coverage by welfare distribution quintiles and a stratified analysis by country income levels. We used the same criteria as used for the regressions in the overall population: Poisson model with fixed-effects and robust random errors, adjusted by the SEH factors. The factors chosen for the specific regression analyses showed in Table 3. Table4. Table 5. And Table 6., were considered by the research team as the most relevant determinants to be studied, and for which good quality data could be found: sex and age-groups (from the GBD-2019), country income level (according to PPP) and welfare distribution quintiles as classified by the World Bank Development Indicators (WBDI) (23, 26, 30).
8. As part of the sensitivity analysis, we decided to re-run our analysis for the total population (see Appendix 1.) categorizing the main predictive variable, SPL programs, by three levels of the coverage indicator (low coverage: 0-29%; intermediate coverage: 30-69%; consolidate coverage: 70-100%), according to previous works strategies (35), and dichotomizing the SEH variables by their median value. We did this to give more robustness to the results extracted from the analysis using count-data regressions, and to verified if the main effects could be spurious or, on the contrary, could be taken as reasonable according to the literature.

2.4. Ethical considerations

All datasets from which information was extracted for the purpose of this research were provided and approved by the HIA team of the Barcelona Institute for Global Health (ISGlobal), Spain. As this study exclusively used aggregate secondary data from official and public domain sources, ethics approval by a research ethics committee and informed consent are waived.

3. RESULTS

3.1. Suicide mortality rates overall and by sex, age, and stratified by income levels

A total of 81 low-and-middle-income countries were included in the conduct of this investigation after meeting the inclusion criteria established. Our study population belong to all five different WHO regions: Africa, Americas, Asia, Oceania, and Europe (1). In Table1. there is a description of the main outcome characteristics according to three cut points for every 10 years of follow-up (2000, 2010 and 2019). It also shows the percentage mean difference for the overall and stratified suicide mortality rates of the population between the year of onset in 2000 and the end of the follow-up period in 2019.

Overall, there was a gradual decrease in the suicide mortality rates in the population during the study period. Same pattern was observed in the suicide rates by sex, age, and income level categories. By looking at the mean and SD, the total age-standardized suicide mortality rates represented quite accurately the rates for the entire population in our analysis, except for the elder categories (over 50-years) of age which exceed the rates of this estimation. The age-standardized suicide rates experienced an overall mean decreased of 2.25%, with 9.76 deaths per 100 000 inhabitants in 2019 compared to the 12.01 deaths per 100 000 inhabitants by the onset of the study in the year 2000.

Table 1. **Summary statistics of suicide mortality rates overall, by sex, age, and stratified by income levels in the 81 LMICs, 2000-2019**

	2000		2010		2019		% Change
	Mean	SD	Mean	SD	Mean	SD	2000-2019
Suicide mortality rates							
Total suicide mortality* (n=81)	12.01	7.59	10.89	7.28	9.76	6.16	-2.25
By sex* (n=81)							
Female	5.73	3.54	4.96	3.02	4.31	2.57	-1.42
Male	19.00	13.46	17.47	13.04	15.76	11.03	-3.24
By age** (n=81)							
10-24 years	7.17	6.18	6.62	5.96	5.74	4.71	-1.43
25-49 years	14.69	11.08	13.37	10.50	11.90	8.61	-2.79
50-69 years	20.86	14.98	18.72	14.49	16.74	12.47	-4.12
70+ years	30.79	22.25	28.48	20.91	26.80	19.38	-3.99
Country income level*							
Low-income (n=12)	14.09	7.42	11.73	5.64	10.42	4.65	-3.67
Lower-middle income (n=31)	13.48	8.57	12.58	9.03	11.01	7.48	-2.47
Upper-middle income (n=38)	10.15	6.46	9.41	5.79	8.48	5.26	-1.67

* Age-standardized rates; ** Crude rates; SD: standard deviation

Note: Rates per 100 000 population

Both females and males showed a decrease in the suicide rates during the entire period (1.42% and 3.24% respectively), with males experiencing more than 3 times the suicide rates of females for the entire 20-years of follow-up.

By age groups, there is a gradient increase in the suicide mortality rates. The rates in the youngest age group (10-24 years) had a mean reduction of 7.11 in 2000 to 5.74 deaths per 100 000 population in 2019, while the rates in the eldest group (70+ years) had the highest rates ranging from 30.79 in 2000 to 26,80 deaths per 100 000 population in 2019. These differences between the age groups were consistent for each of the cut points of time and for the entire 20 year-period. Nevertheless, also the population over 50 years were the ones with a higher reduction in the suicide mortality rates, being those between 50-69 years the ones with a greater decrease (4.12%) in the mortality rates by 2019. On the other hand, the 10-24 years group had the lowest reduction of all groups with a 1.43% change.

According to the national income level, the low-income countries showed the higher rates of suicide mortality decreasing from 14.09 to 10.42 deaths per 100 000 people during the 20 years, whereas the upper-middle income countries had the lowest rates, decreasing from 10.15 to 8.48 deaths per 100 000 people. Lower-middle income countries showed a 2.47% decrease in their mortality rates which ranged from 13.48 to 11.01 deaths per 100 000 people. The countries with the highest rates were also the ones with the greatest % reduction in their mortality rates by the year 2019; a 3.67% change in low-income countries compared to a 1.67% reduction for the upper-middle income countries.

3.2. Coverage of SPL programs overall, by wealth distribution and income levels

The percentage of mean-change in Table 2. refers to the coverage difference between the start and the end of the 20 years period of study from 2000 to 2019. In general, there is an increased change in the mean coverage of SPL programs for the crude population with a 12.76% increase changing from a 35.07% to a 47.83% of total coverage, also we described this general increase when adjusted by all different welfare distribution categories.

By quintiles of welfare distribution, there is a gradient decrease (higher in poorest, lower in richest) in the percentage of total SPL coverage, being those in the 1st quintile the ones more covered at any given point of time (42.51% for 2000, 55.83% for 2010 and 61.98% for 2019). Also, the poorest categories were those increasing their proportion of coverage the most by the end of the study period in 2019, a 21.89% growth for the

extreme poor and a 19.47% increase for the whole 1st quintile. On the contrary, those in the richest quintile (5th quintile), where accordingly the ones with less SPL coverage for the entire period coming from a 28.61% coverage in 2000 to a 32.74% coverage by 2019, a 4.13% mean increase.

Table 2. Summary statistics of all explanatory variables for the 81 LMICs, 2000-2019

	2000		2010		2019		% Change
	Mean	SD	Mean	SD	Mean	SD	2000-2019
Coverage of SPL programs (%)*							
Total SPL programs (n=81)	35.07	32.93	43.84	25.78	47.83	27.55	12.76
By welfare distribution (n=81)							
Extreme poor (<$1.9 a day)**	44.41	38.94	56.27	32.97	66.30	33.98	21.89
1st quintile (poorest)	42.51	37.72	55.83	32.44	61.98	32.64	19.47
2nd quintile	37.14	35.17	48.83	29.53	53.59	31.82	16.45
3rd quintile	33.93	34.15	44.17	26.84	48.50	29.41	14.57
4th quintile	31.68	32.65	38.81	23.71	41.63	27.03	9.95
5th quintile (richest)	28.61	30.21	31.60	19.48	32.74	21.67	4.13
Country income level							
Low-income (n=12)	27.95	25.04	15.87	9.71	17.19	16.97	-10.76
Lower-middle income (n=31)	17.91	26.75	34.11	25.32	45.74	30.22	27.83
Upper-middle income (n=38)	49.55	32.69	58.81	16.12	57.32	18.95	7.77
SEH variables* (n=81)**							
Depressive disorders	3.63	0.95	3.70	0.89	3.86	0.82	0.23
Age dependency ratio	67.16	18.71	59.48	18.30	58.55	16.55	-8.61
Health expenditure	5.61	2.75	6.46	2.82	6.43	3.15	0.82
Unemployment	8.07	6.06	8.16	5.57	7.12	4.81	-0.95
Literacy rate	78.11	17.79	82.39	18.93	87.67	15.98	9.56
Interpersonal violence	3.18	0.90	3.24	0.98	3.30	1.01	0.12
Gini index	38.75	9.11	36.72	6.87	37.62	8.63	-1.13

*(%) of total population covered

**Extreme poor (<$1.9 a day) is part of the 1st quintile and was extracted from it for analytical purposes.

***Depressive disorders (all ages %), interpersonal violence (all ages %), age dependency ratio (% of total working-age population) current health expenditure (% of GDP), unemployment (% of total labor force), adult literacy rate (% of people over 14 years) and Gini Index

Finally, stratifying by national income level, the population in the upper-middle income countries (n=38) were the ones better covered by SPL programs, starting the period with a 49.55% and finishing with a 57.32% of coverage. The population in lower-middle income countries (n=31), changed from being the ones least covered by 2000 (17.91%) to being the ones experiencing a greater change by the end of the study period, with a 27.83% increase (45.74% of population covered) by the year 2019. The low-income countries (n=12), had fluctuations in the proportion of population covered during the whole period, starting with a 27.95% in 2000 going down to 15.87% and increasing again

to 17.19% by 2019. In the end, the low-income countries were the only category that experienced an overall decrease in their coverage by 10.76%.

3.3. Characteristics of socioeconomic and health variables

At the end of Table 2. we included the description of the chosen SEH covariates. Overall, there were two covariates undergoing an important change in their mean trends over the 20-years period. Age dependency ratio (-8.61%) which experienced the greatest decrease change by 2019, and on the other side literacy rate (9.56%) which increase the most by the end of the follow-up period. The rest five variables remain almost constant during the whole period, three experiencing a soft positive increase in their mean values; depression disorders (0.23%), health expenditure (0.82%), and interpersonal violence (0.12%), while the other two underwent a slight negative change; unemployment (-0.95%) and Gini index (-1.13%).

3.4. Comparison of self-harm rates and SPL programs between onset and end of the study period, 2000-2019.

To have a better understanding of how the main variables, suicide rates and SPL programs, evolved in our sample population (81 LMIC) across the 20 years of investigation, we decided to create two scatterplots as shown below in Figure 1. The figure displays two different moments, (A) for the year when this study started in 2000, and (B) for the year of study ending in 2019.

We had set two threshold points, for suicide rates in 15 deaths per 100 000 population (horizontal line in red), and for SPL programs in 0.7 (or 70%) of total population covered (vertical blue line). With this, we wanted to better illustrate those countries having higher suicide rates, as well as those presenting a more consolidated coverage of their social protection and labor programs for each year (1, 11, 35).

Overall, we can graphically see that there were more countries above the suicide threshold line (countries with > 15 deaths per 100 000population) in 2000 (A), than in 2019 (B). In addition, for the year 2000 (A) we can see more countries with a proportion of coverage closer to 0 (lower coverage) than what is described for the year 2019 (B).

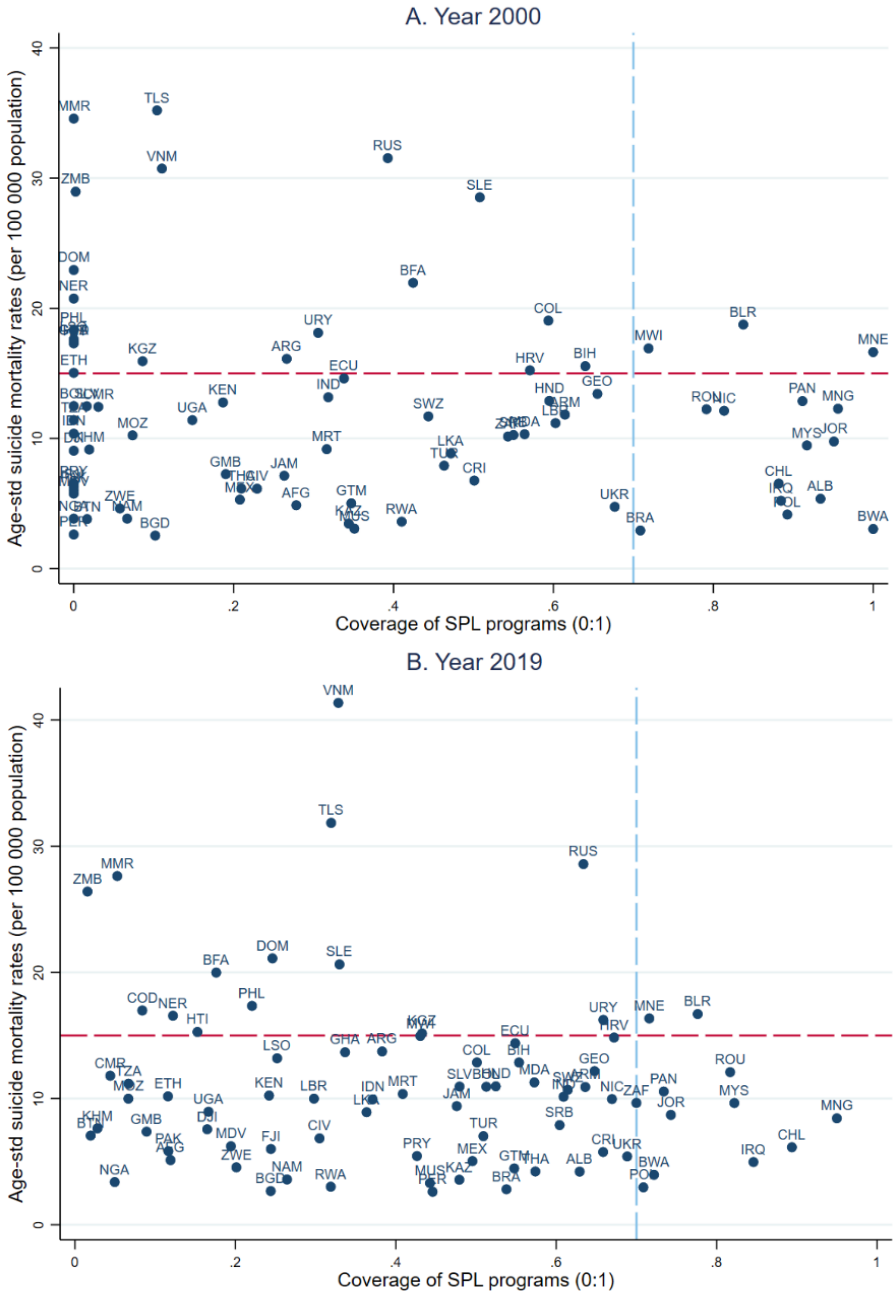


Figure 2. Evolution of suicide mortality rates and coverage of SPL programs by country (n=81). (**A**) Suicide rates and proportion of SPL coverage for the year of onset in 2000; (**B**) Suicide rates and proportion of SPL coverage by the end of the study period in 2019. Horizontal (**red**) line shows the suicide threshold set in 15 deaths per 100k; Vertical (**blue**) line shows the coverage threshold set in 0.7 (0:1) coverage of total population.

3.5. Effects of SPL coverage on overall suicide mortality rates

In Table 3. there is a replication of the results found from the crude Poisson regression analyses and by adjusting for the final selection of SEH variables. These results are shown for the total population (n=81) and by welfare distribution quintiles.

Table 3. Effects of SPL coverage on suicide mortality rates in the 81 LMICs, 2000-2019

Coverage of SPL programs (%)*	Suicide mortality rates (per 100 000 population)					
	Crude model			Adjusted model***		
	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI
Total population (n=81)	0.82	0.010	0.70 - 0.95	0.83	0.003	0.74 - 0.94
By welfare distribution (n=81)						
Extreme poor (<$1.9 a day)**	0.83	0.012	0.72 - 0.96	0.86	0.003	0.77 - 0.95
1st quintile (poorest)	0.82	0.002	0.73 - 0.93	0.85	0.004	0.76 - 0.95
2nd quintile	0.84	0.007	0.74 - 0.95	0.86	0.004	0.78 - 0.95
3rd quintile	0.82	0.006	0.71 - 0.95	0.84	0.003	0.75 - 0.94
4th quintile	0.85	0.026	0.73 - 0.98	0.85	0.005	0.76 - 0.95
5th quintile (richest)	0.90	0.226	0.75 - 1.07	0.88	0.080	0.77 - 1.01

IRR: Incidence-rate ratio; P>|z|: p-value; 95%CI: 95% confidence interval; Applied robust standard errors

*(%) of total population

**Extreme poor (<$1.9 a day) is part of the 1st quintile and was extracted from it for analytical purposes.

***Adjusted by all SEH variables: depressive disorders (all ages %), interpersonal violence (all ages %), age dependency ratio (% of total working-age population) current health expenditure (% of GDP), unemployment (% of total labor force), adult literacy rate (% of people over 14 years) and Gini Index

The overall population suicide death rates showed statistically significant reductions of their IRRs, both for the crude and adjusted models with (0.82, 95% CI: 0.70 – 0.95) and (0.83, 95% CI: 0.74 – 0.94) respectively.

The SPL coverages by welfare distribution quintile (based on the PPP) also showed significant reductions in the overall suicide rate, except the coverage targeting the population in the richest quintile (5th quintile). The coverages in the poorest quintile (1st quintile) and 3rd quintile had a higher mortality reduction for the crude analysis, both with a 0.18% reduction in their IRRs for each unit of coverage increase in social protection programs. For the adjusted analysis, the population in the 3rd quintile showed the greatest reduction in their IRRs (0.84, 95% CI: 075 – 0.94), closely followed by the poorest population (0.85, 95% CI: 0.76 – 0.95) and those in the 4th quintile (0.85, 95% CI: 0.76 – 0.95).

3.6. Effects s of SPL coverage on sex-specific suicide mortality rates

Table 4. shows the description of the results for the sex-specific (male and female) adjusted analysis both in the total population and by quintiles of welfare distribution for the SPL coverage variable.

Overall, the total population in both female and male groups show statistically significant reductions in their suicide mortality IRRs due to the effects of SPL programs coverage. This pattern was repeated by all wealth distribution quintiles, with the exception of both

males and females of the richest quintile (5th quintile), for whom results were not statistically significant.

Table 4. Effects of SPL coverage on sex-specific suicide mortality rates in the 81 LMICs, 2000-2019

Coverage of SPL programs (%)*	Sex-specific suicide mortality rates** (per 100 000 population)					
	Female			Male		
	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI
Total population (n=81)	0.84	0.014	0.73 - 0.97	0.83	0.004	0.73 - 0.94
By welfare distribution (n=81)						
Extreme poor (<$1.9 a day)	0.86	0.014	0.76 - 0.97	0.86	0.004	0.77 - 0.95
1st quintile (poorest)	0.87	0.038	0.76 - 0.99	0.84	0.003	0.76 - 0.94
2nd quintile	0.86	0.025	0.76 - 0.98	0.86	0.004	0.78 - 0.95
3rd quintile	0.84	0.004	0.75 - 0.95	0.84	0.005	0.74 - 0.95
4th quintile	0.86	0.017	0.76 - 0.97	0.85	0.008	0.75 - 0.96
5th quintile (richest)	0.91	0.155	0.79 - 1.04	0.87	0.089	0.75 - 1.02

IRR: Incidence-rate ratio; P>|z|: p-value; 95%CI: 95% confidence interval. Applied robust standard errors

* (%) of total population

**Adjusted by all covariates: depressive disorders (all ages %), interpersonal violence (all ages %), age dependency ratio (% of total working-age population) current health expenditure (% of GDP), unemployment (% of total labor force), adult literacy rate (% of people over 14 years) and Gini Index

Males show slightly more significant reductions in their suicide mortality IRRs than females; (0.83, 95% CI:0.73 -0.94) in males vs (0.84, 95%CI: 0.73 – 0.97) for females. The general male population showed slightly higher reductions in the suicide mortality rates than when distributed by welfare categories.

By welfare distribution, males in the poorest (1st quintile), and in the 3rd quintile presented the greatest significant effects of SPL coverage over the suicide mortality reduction (0.84, 95% CI: 0.76 – 0.94) and (0.84, 95% CI: 0.74 – 0.95) respectively; whereas in the female population, those in the 3rd quintile of welfare distribution, showed the greatest IRR suicide mortality reduction of all quintiles, with a 16% decreased in the suicide mortality rates for every 1 unit increase of SPL programs coverage.

3.7. Effects of SPL coverage on age-specific suicide mortality rates

Results displayed in Table 5. describe the effects of SPL programs coverage in the suicide mortality rates of the population over the 20-years by 4 age-specific groups: 10-24 years, 25-49 years, 50-69 years, and 70 years or more.

Table 5. Effects of SPL programs on age-specific suicide mortality rates in the 81 LMICs, 2000-2019

Coverage of SPL programs (%)*	Suicide mortality rates (per 100 000 population)											
	10-24 years			25-49 years			50-69 years			70+ years		
	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI
Overall population (n=81)	0.81	0.010	0.69 - 0.95	0.84	0.011	0.73 - 0.96	0.83	0.007	0.71 - 0.95	0.86	0.003	0.78 - 0.95
By welfare distribution (n=81)												
Extreme poor (<$1.9 a day)	0.80	0.000	0.71 - 0.92	0.87	0.011	0.78 - 0.97	0.86	0.014	0.76 - 0.97	0.87	0.001	0.80 - 0.94
1st quintile (poorest)	0.81	0.003	0.70 - 0.93	0.85	0.008	0.76 - 0.96	0.85	0.015	0.75 - 0.97	0.88	0.008	0.80 - 0.97
2nd quintile	0.84	0.007	0.75 - 0.95	0.86	0.006	0.78 - 0.96	0.86	0.030	0.76 - 0.99	0.88	0.022	0.79 - 0.98
3rd quintile	0.81	0.009	0.69 - 0.95	0.84	0.006	0.74 - 0.95	0.84	0.009	0.73 - 0.96	0.88	0.006	0.80 - 0.96
4th quintile	0.83	0.018	0.71 - 0.97	0.86	0.027	0.76 - 0.98	0.84	0.006	0.74 - 0.95	0.87	0.003	0.80 - 0.95
5th quintile (richest)	0.87	0.187	0.72 - 1.07	0.90	0.218	0.76 - 1.06	0.86	0.034	0.75 - 0.99	0.89	0.027	0.81 - 0.99

IRR: Incidence-rate ratio; P>|z|: p-value; 95%CI: 95% confidence interval. Applied robust standard errors

* (%) of total population

**Adjusted by all covariates: depressive disorders (all ages %), interpersonal violence (all ages %), age dependency ratio (% of total working-age population) current health expenditure (% of GDP), unemployment (% of total labor force), adult literacy rate (% of people over 14 years) and Gini Index

The age-specific analyses, presents highly significant effects of SPL coverage in reducing the suicide mortality rates for the overall population in each age-group category. The only exception is found among the richest (5th quintile) people aged 49 years or less, who showed no significant effects of SPL coverage over the suicide rates.

Overall, the youngest population (10-24 years) had the highest suicide mortality IRR reduction among all age-groups due to the coverage of SPL programs, with a 19% decrease in the suicide mortality rates of its population for every 1 unit increase of SPL programs coverage during the 20-year period between 2000 and 2019. Closely followed by the 50-69 years group (0.83, 95% CI: 0.71 – 0.95), the 25-49 years group (0.84, 95% CI: 0.73 – 0.96) and lastly, the oldest population of 70 years or more (0.86, 95% CI: 0.78 – 0.95).

By welfare distribution categories, the highest reduction in the IRR suicide mortality, was found for the extreme-poor young population of 10-24 years. This group displayed an effect of 20% reduction in the suicide death rates for every 1 unit increase of SPL coverage in the period between 2000 and 2019. Lastly, it outstands that the elder population (50 years or more), showed significant suicide mortality IRRs reductions for all welfare distribution subgroups, with nearly no statistical differences due to the welfare quintile status of the population (n=81).

3.8. Effects of SPL coverage on income-level stratified suicide mortality rates

Results shown in Table 6. describe the effects of SPL programs coverage in the suicide mortality rates for the total population (n=81), and for the stratifying groups by three

income levels: low-income countries (n=12), lower-middle income countries (n=31), and upper-middle income countries (n=38) (26).

Table 6. Effects of SPL programs on stratified suicide mortality rates by country income levels, 2000-201

Variables	Suicide mortality rates (per 100 000 population)											
	Total population (n=81)			Low income (n=12)			Lower-M income (n=31)			Upper-M income (n=38)		
	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI	IRR	P>|z|	95%CI
Coverage of SPL programs (%)*	0.83	0.003	0.74 - 0.94	0.87	0.220	0.71 - 1.08	0.74	0.000	0.64 - 0.85	0.97	0.630	0.86 - 1.10
Depressive disorders	0.84	0.043	0.71 - 1.00	0.69	0.312	0.34 - 1.42	0.68	0.035	0.48 - 0.97	0.98	0.418	0.90 - 1.04
Age dependency ratio	0.99	0518	0.99 - 1.00	0.99	0.586	0.98 - 1.01	1.07	0.368	0.98 - 1.01	1.00	0.926	0.99 - 1.01
Health expenditure	0.98	0.026	0.98 - 1.00	0.98	0.310	0.95 - 1.01	0.94	0.087	0.58 - 1.00	0.98	0.029	0.97 - 1.00
unemployment	1.00	0.391	1.00 - 1.01	1.00	0.422	0.99 - 1.01	1.02	0.946	0.99 - 1.01	1.00	0.752	0.99 - 1.00
Adult literacy rate	0.99	0.000	0.98 - 1.00	0.98	0.116	0.98 - 1.00	0.94	0.005	0.99 - 1.00	1.00	0.000	0.98 - 1.00
Interpersonal violence	1.04	0.670	0.85 - 1.28	0.97	0.904	0.52 - 1.77	1.05	0.349	0.85 - 1.59	1.05	0.619	0.87 - 1.27
Gini Index	1.00	0.080	0.99 - 1.01	1.00	0.332	0.99 - 1.02	1.03	0.204	0.99 - 1.01	1.00	0.246	1.00 - 1.01

IRR: Incidence-rate ratio; 95%CI: 95% confidence interval; RSE: robust standard errors; P>|z|: p-value, Age-standardized suicide rates; Lower-M: lower-middle; Upper-M: upper-middle

Coverage of SPL programs (% of total population), depressive disorders (% all ages), interpersonal violence (% all ages), age dependency ratio (% of working-age population) current health expenditure (% of GDP), unemployment (% of total labor force), adult literacy rate (% of people over 14 years) and Gini Index

As previously mentioned in Table 3., Table 6. shows how the total population suicide death had statistically significant reductions of their IRRs (0.83, 95% CI: 0.74 – 0.94). However, when stratification of the total population is made by the countries' income-levels, our analyses described significant results only for the lower-middle income countries (n=31) with a reduction in their suicide mortality rates of 26% for every 1 unit increase in the SPL programs coverage. Meanwhile, low-income countries (IRR:0.87, 95% CI: 0.71 – 1.08) and upper-middle income countries (IRR:0.97, 95% CI:0.86 – 1.10) show no statistically significant effects. The fact that the original effects in the total population just hold up in the lower-income group but not in the other two groups when stratification is made by income levels, will be further explored in the discussion.

Finally, the regression analyses also show that among the confounding variables depressive disorders, health expenditure and adult literacy rates had statistically significant results for the total population with a reduction in the outcome IRRs of 16%, 2% and 1% respectively, for every 1 unit increase in the SPL coverage. In the lower-income category, these effects are still significant for the depressive disorders IRR (0.68, 95%CI: 0.48 -0.97) and for the adult literacy rate IRR (0.94, 95% CI:0.99 -1,00).

4. DISCUSSION

4.1. Key points

This study explored over a 20-year period (2000-2019), the effects of social protection and labor programs over the suicide rates of a diverse sample of 81 low-and-middle income countries.

Overall, our results suggest that SPL programs may have had a protective effect on reducing the suicide mortality rates on our sample population between 2000 and 2019. In fact, Table 1. and Table 2. show that, overall, an increase in the coverage of SPL programs was accompanied by the reduction of the suicide rates in the population (n=81) during the period 2000-2019. The effects of this association were observed in the total population for both the crude and adjusted analysis (Table 3.), and for most of the adjust-specific analyses by sex (Table 4.) and age (Table 5.). Also, there were significant effects of SPL programs over the suicide rates when the population was classified according to the welfare distribution quintiles (poorest to richest), for all quintiles except the richest quintile (5^{th}) which just had significant SPL effects on their suicide mortality for the population 50 years or older.

These findings are in line with previous studies made separately to study suicide trends, like the last Suicide Worldwide report by WHO (2019) (1); and to study the implementation over time of social protection measures as described by the last report of the Official Development Assistance (ODA) (37) and other related publications (3, 13). However, to explain the possible protective role of social protection over the suicide deaths of the 81 LMIC we need a further comprehension of the existing evidence.

A plausible hypothesis is that, as presented by Yur'yev A. et al. (38), the more SPL programs are implemented in a population's country, the less burden of stress these individuals will experience (about possible economic or personal crisis), and the better prepared and accompanied they will feel to successfully accomplish the challenges of daily life, including the experience of suicidal thoughts. This study, acknowledge that SPL measures are made mostly to help struggling individuals climb out of poverty (11, 18), and therefore, it was reasonable to find in our results (in Table 2.) that SPL coverage was gradually higher among the poorest welfare quintiles (extreme poor being the most covered). Likewise, these groups had the biggest increase in their social protection coverage by the year 2019. However, this reasoning did not apply for the entire sample population.

When stratifying the countries by income levels, both lower-middle and upper-middle income categories showed an increased SPL coverage, while those classified as low-

income countries (poorest), shown to be the least covered for much of the period. Furthermore, the low-income countries (n=12) were the only group suffering a decrease (10.76%) in their SPL coverage between 2000 and 2019 (Table 2).

To better understand the specific evolution of each of these 12 low-income countries, we displayed in Appendix 3. a graphical representation of the evolution of the LIC suicide mortality rate trends and their SPL coverage over the period 2000-2019 . Overall, while the suicide rates of most LIC had notably decreased by 2019, they also suffered a dramatic reduction in their SPL coverage. This is the case of Malawi (MWI), which had a consolidated coverage (over 70%) in the year 2000 that dropped to about 40% by 2019.The reduction of the social coverage in LIC, could help explaining why, when performing the stratified regression analysis by national income levels (Table 6.), against the expected, the results of covering SPL programs in the “poorest” low-income states had not statistically significant effects on reducing their suicide mortality rates. In fact, the only group describing a significant reduction on their suicide rates were the lower-middle income countries (n=31).

It has been hypothesized that larger economic shocks, such as GDP falls, unemployment, and debt, may trigger policymakers to make deep social and healthcare cuts (8, 9, 17, 22). Furthermore, internal conflicts or disease outbreaks can originate economic instabilities and a lack of resources, which may explain why some governments would choose to cut on social protection programs in favor of other more urgent targets. In their paper, McCord, A. et al., examined the official development assistance (ODA), which is the main financing source of foreign development-aid in LMIC, and also, ODA’s role in enhancing social protection systems in LMIC since the start of the millennium (37). As graphically described by the Appendix 4., funding for social protection spiked in 2006 due to many debt relief initiatives that highlighted the importance of targeting social protection programs for the least developed economies (13, 37). However, the ODA report also explains how most of the funding was given to enhance poor countries, but that already had an ongoing social protection structure. This description could fit with the lower-middle income countries, explaining why these countries showed the highest increase (27.83%) in the SPL coverage by the year 2019 (Table 2) and very significant effects when the stratification was made according to the income levels (Table 6.). Furthermore, the global financial crisis of 2008 is also mentioned in a time trend study in 54 countries (17) as a trigger factor that made low-income economies lose part of their domestic and external financial investment destined to social protection interventions (37). The authors, also pointed out that the struggles of an economic recession take much more time for a least developed economy to

overcome, leaving their individuals more vulnerable to develop suicide behaviors even time after the economy is already recovered (17).

This scenario is very worrisome, as social protection programs aim to target mainly the poorest, but because of their particular struggling situations, very often LIC lack a structure and the minimum resources needed to adequately implement and benefit from any international SPL intervention (13, 37). This creates a paradox known as the "Inverse equity hypothesis", which claims that any set of new social and health aid interventions will be initially adopted by those with sufficient financial means, and hence, increase inequalities as the poorest states will continue to be left behind (39). It may explain why in our different regression analysis, we could not clearly observe a greater beneficial effect of SPL programs on the suicide rates of the poorest quintiles of the population as it would be expected. In fact, we very often observed the outcome IRRs reduction to be very similar between the different welfare quintiles and in the different regressions (Table 3., Table 4., And Table 5). Furthermore, we should consider an underestimation of the effects in LIC due to gaps in the suicide deaths measurement. Firstly, because LIC are underrepresented in this study, (only 12 out of more than 40 total LIC), and secondly, because as shown in Table 1., the low-income countries had the highest reduction (3.69%) in the suicide mortality rates by 2019 in compared to the other income levels, which could be a result of a faster improvement in their notification systems (1, 2, 40).

The population in this study, was also adjusted by both gender and age to explore how the effects of the main associated variables specifically developed across the life course of the 81 LMIC sample. Most of the papers reviewed during this investigation had their focus on high income economies, which have a very different socioeconomic and contextual environment that needs to be carefully explored (1, 3, 12). Therefore, we decided to illustrate the sex-specific variations of the 81 LMIC across the 20-year period of study by displaying Appendix 5. and Appendix 6., as sex is an especially decisive factor in LMIC, for both suicide mortality rates and social protection coverage.

For example, it has been identified that social protection and labor programs affect differently males and females, even increasing existing inequalities (2, 3, 41). These social programs usually target the formal sector (insurances and pensions), where women, especially in LMIC are under-represented, and therefore, they are more likely to be excluded from that social protection benefits (3, 42, 43). Our results, show similar effects of SPL programs for both sexes in the sex-specific adjusted analysis with, overall, slightly higher reductions in male suicide rates (Table 3.). As we can see in the Appendix

7., suicide rates for both men and women are not equally distributed across all five WHO regions (1). For males, the Americas and Asia regions described the greatest rates throughout the 20 years period, being the Americas region the one accounting the largest rates by the end of 2019. For females, Africa notoriously accounted for the highest suicide rates among all 5 regions with more than 15 deaths per 100 000 by the start period in 2000 reducing its distance with the other 4 regions by the end of the period with about 10 deaths per 100 000 population by 2019. These data contrast with the previously mentioned report on suicide by the WHO (2019) (1), which estimated in 5.4 per 100 000 the global female suicide rates; the SEA region had the greatest female rates of all, and for males, Africa was the region that by far accounted for the greatest suicide burden (18 per 100 000 population) by 2019. The considerable variations in the rates presented here compared to other national and international estimates could reflect the unreliability of the suicide data for LMIC (12, 40), and the importance of the cultural context of each specific country (15, 19, 20, 41). Moreover, our estimates can vary due to the country selection we made for the different regions according, mainly, to the availability of data for SPL programs (32).

By looking at the Appendix 5. we can see how the highest suicide rates in males were among Myanmar (MMR), Timor-Leste (TLS) and Vietnam (VNM), and all three countries from the Asian region. As cited by Dr San San Oo, psychiatrist at Aung Clinic in Yangon (Myanmar), most of the explanation on why males commit suicide is due to socio-normative expectations in the country that put men under the pressure of being the family keeper and income provider at any cost, which derives in men having toxic behaviors (alcohol, drugs) as compensatory measures (46). Furthermore, taboo continues surrounding depression and mental illnesses in many Asian countries, as in the case of some Buddhist communities, that have the belief that, those who commit suicide will suicide again in their 500 next lives (45, 46, 47). In females, two African economies also stand out in our study, Niger (NER) and Zambia (ZMB) (see Appendix 6.). A systematic review on suicidal behaviors in Africa (48), highlighted the religious and cultural stigma as a cause for under-reporting, hiding or deliberately misclassify suicide cases in many countries. In addition, female suicide rates may be more misclassified than males. A study made in South Africa, suggested that suicide deaths by poisoning, jumping and railways are more likely to be misclassified than those by firearms or hanging, and are precisely the former methods the most used ways of attempting suicide among females (49). These highlights again the need for more research on the contextual aspects surrounding suicide in LMIC and the use of standardized methods to better classified suicide cases (3, 6, 40).

To continue exploring the effects of demographical factors in our study, we presented Table 5. containing the results that the effects of SPL programs had on reducing the suicide rates in age-specific subgroups of the population (n=81). Adjusting by age-groups, we found some statistically significant differences in the effects of SPL programs on suicide mortality, especially among the youngest (10-24 years) and oldest (70 or more) strata. It is remarkable to observe that SPL programs showed significant IRR suicide mortality reduction for every and each of the different welfare quintiles among the oldest age-groups of 50 years and more. It also stands out that among all age groups, the youngest population were the ones most beneficiated from the SPL coverage, particularly the extreme poor subgroup.

According to the WHO, more than 58% of total suicide burden is borne by the population under 50 years, however, separated by age-groups the population over 70 years are the ones suffering the most suicide deaths across all five WHO regions (1, 6). These differences in the age profile, are explained by different demographical and cultural factors. First, although the most suicidal group are the eldest, the total population living over 70 years is not that frequent as for other age groups, particularly in LMIC (50). In addition, some of the most populated countries in the world like India or China present a much younger population structure than other countries, which explains why the total number of suicides is greater in the younger groups (45, 50). Apart from that, there are several social and contextual factors that may explain why SPL programs, could had a greater effect on reducing the suicide burden among the youngest group. In a study published on 2018 made on the suicide attempts admitted to a tertiary hospital in Bangalore (India), the researchers found most of the attempters to be individuals between 15 and 24 years (44). The characteristics more frequently described by this age group was being married, strong nuclear-family beliefs, low educational levels, housewives, and professing Hinduism. Experiencing family problems were the most recurrent reason for attempting suicide, followed by marital issues (interpersonal and sexual violence), financial constraints and alcohol dependence in 16% of the patients. Self-harm methods and triggers also varied; being usually a result of an impulsive act (rather than premeditate), with pesticides as the most recurrent method used for suicide in rural areas in comparison to hanging or firearms in the urban youth (44). There are other studies describing similar patterns on the suicidal behaviors among the young population (46, 48, 49).

On the other side of the age pyramid, another study in India described the population over 65 years to have higher rates of family or personal mental-illness history, other

concurrent illness, and a recent history of medical contact 3 months prior to attempting suicide (51). Stressors that trigger these behaviors were linked to financial constrains linked to unemployment, toxic habits, and being from rural areas where elderly people suffer from greater social isolation than younger age groups (51). These findings reinforce the idea of the significant associations displayed by our results in Table 5. as, well implemented SPL programs would offer the most vulnerable subgroups of population, (often young and elder groups), with the social structure (subsidies, mental or obstetrical healthcare, employment, and educational opportunities) they need to overcome the struggles of everyday life and prevent them from experiencing suicidal behaviors (16).

Lastly, Table 6. (and Appendix 1.) also displays the regression analysis for the main associated variables (SPL programs and total suicide rates (n=81)) adjusted by seven SEH factors for the period 2000-2019. Three of these cofactors presented statistically significant results. Adult literacy rate (% of total people over 14 years) showed very small beneficial effect on the main association IRR reduction (0.99, 95% CI: 0.98 – 1.00), although it has been described in the literature the important role of enhancing literacy to empower individuals to participate and be productive members of the society (6, 35, 43). This no effect on the suicide rates, could be explained by the duality between positive and negative effects literacy empowerment brings to individuals, especially women. Dana G.Smith, exposed in her work the alarming case of Indian females, which account for one third of the total female suicide mortality burden worldwide (52). G.Smith pointed at the acceleration of women education and empowerment in many south-regions of India as a source of psychological distress, as it frontally contrasted with traditional beliefs that put women at “service” of a very rigid domestic (and sometimes violent) environment (32). Similar situations for women were described in other studies made in China and Fiji hospitals (42, 45). To continue with, health expenditure (% of current GDP) is other of the factors that had statistically significant results, showing a protective effect on the association between SPL programs and suicide rates, with a reduction on its IRR (0.98, 95% CI: 0.98-1.00) (Table 6. for total population). The fact that health expenditure could impact on this association has been widely described in the literature as for example, the more money the governments invest in mental or maternal health programs, the better support by society the individuals will feel to face health stressful situations, and therefore, the less frequent they may feel overwhelmed so as to develop suicidal ideations (3,12,16, 17, 35) . Finally, depressive disorders showed, far from any expected (see Table 6. for total population), protective significant effects on reducing suicide mortality, IRR (0.84, 95% IC: 0.71-1.00). However, these

results have a 95% CI almost crossing the null value (1.00), which can derive from the use of imperfect data in our study (27, 33). Nevertheless, there is also some evidence that could partially explain why experiencing depression disorders could impact positively on reducing the suicide rates of our population. A systematic review made in 2021, presented the case of universal school-based programs for promoting mental health to students aging 6 to 18 years in different LMIC (53). Although limited, some studies presented positive significant effects in the reduction of anxiety and depression outcomes for the children and adolescent of LMIC schools. Therefore, even if suicide is not the direct target of a health intervention, by targeting depression disorders and act to reduce it, indirectly, these interventions could as well have a protective effect against experiencing suicidal behaviors (53, 54).

4.2. Strengths of the study

This study is the first to our knowledge that quantitatively examines the effects of SPL programs coverage on the suicide mortality rates of the population living in low-and-middle income countries. Our main results suggested that social protection initiatives (not limited to just health activities), could play a very positive effect on reducing suicide mortality in LMIC. This study included the biggest sample population for which enough quality data was available for both, the suicide outcome, and the explanatory variable of social protection, which made us end up with a considerable sample size of 81 LMIC. In addition, we followed these countries for the longer period of time for which data was also feasible and relevant to obtain, which was a 20-year period between 2000 and 2019. Using a longitudinal panel data analysis rather than a cross-sectional analysis let us explore the effects of social protection interventions and SEH factors within the countries and over time. This allowed the analyses to be possibly more robust and gives more strength to the effects described in the results. Furthermore, our study is relevant to the time, as both suicide and social protection are important factors that have been claimed in the last UN-SNG' agenda to be immediately addressed (11). We did explore the effects of this association for the overall population, but also on relevant subgroups by sex, age, and poverty. Studying the effects of poverty (by income level stratification, and specific welfare quintiles) allowed us to bring some light about the existing disparities in terms of SPL coverage within and between countries in different income levels, which could help in future advocacy for a public health response. Lastly, as we used interpolation and extrapolation statistical methods, we achieved to estimate data gaps in countries that, otherwise, would have dropped from the study, with the consequent loss of valuable information.

4.3. Limitations

Due to the negative connotations surrounding suicide, the existing body of literature is scarce and very imprecise for many WHO regions, especially in low-and-middle-income countries. The African region poses some of the highest suicide rates but gives information on self-harm mortality data for just 16 countries, about 60% of total population in Africa (48). Therefore, data comparability between and within countries could be misclassified and underestimated in our study due to bias in the reporting criteria of each country and time period by; wrongly ascertaining the real cause of death, the subjectivity of the person that completes the death certificates, whether a forensic investigation is made or not, and the confidentiality policy towards the cause of death.

Underestimation and taboo about suicide and other mental illness may lead governments to not invest in social protection interventions that would target this burden (for ex. mental health services). This can be a reason why the LIC group was underrepresented in our study, which could had brought the lost of potential true effects in the stratified analysis. In addition, our main explanatory variable, SPL programs, provides an aggregate count of all the SPL programs combined for each country and year. This means, we cannot verify which specific programs were implemented in the countries nor the quality of their performance. Nevertheless, the use of these techniques has been consolidated for panel data analysis when availability of data is scarce and unlikely to be obtained otherwise (27).

Finally, in our study we used aggregated country level data. This means we lack any source of individual information, and therefore, any assumptions or conclusions extracted from this study should not be infer at the individual level, as this would incur in a case of ecological fallacy (36).

4.4. Public Health implications and recommendations

Our study underlines the existing knowledge gap and the need for more studies to be carried out in LMIC both at the population and individual level. Understanding the potential beneficial effects that social protection interventions can have on reducing socioeconomic inequalities and the suicide rates in LMIC could guide policy makers target the most efficient interventions to prevent suicide, quantify the public health costs, and create strategies to tackle stigma-related behaviors. In addition, promoting and improving standardized methods to accurately classified suicide cases should be a top priority to enable more robust studies and help targeting future and efficient SPL interventions.

Today, attempted suicide continues to be a punishable offence in many countries, which constitutes a critical barrier to suicide reporting and assistance. Therefore, advocating for the destigmatization and decriminalization of suicide and associated mental illnesses need to be a public health priority. Furthermore, other structural factors need to be addressed when planning both suicide prevention efforts and social protection interventions, as many women are still subordinated to their families and are not economically independent to secure their wellbeing. Social protection measures aiming at tackling gender violence and empowering women education should be considered as a potential route for female suicide prevention. Among men, economic stressors were the main key risk factors linked to experiencing suicidal behaviors, suggesting that SPL interventions focused on financial protection could have a greater benefit in reducing male suicide rates.

Lastly, qualitative studies should be considered in LMIC as these studies could bring a broader understanding on how certain sociocultural and contextual factors may be connected to suicidal behaviors.

5. CONCLUSIONS

To our knowledge, this is the first longitudinal study that aims at exploring the effects of social protection on the suicide mortality rates in LMIC. This was an exploratory study which aimed to contribute increasing the scarce body of literature about social protection effects and suicide mortality in LMIC. Results from our analysis suggested that SPL programs could had beneficial effects on reducing the suicide mortality rates of our study population during the period between 2000 and 2019.

Although promoting social protection is included in the last UN Sustainable Development Goals, it was a great concern to see an average 10.76% decrease in the coverage of SPL programs in the low-income countries of our study by 2019. Additional analyses that study the specific causes for this decreased in each country are needed. Moreover, understanding the cultural and contextual particularities of each country could be key in targeting suicide determinants and generate future SPL interventions to reduce suicide-related factors.

Finally, further studies at the population and individual level in LMIC should continue researching on this line to strengthen the evidence of the potential effects SPL programs could have in reducing suicide and help benefiting future research from larger samples and better data quality.

REFERENCES

1. World Health Organization (WHO). Suicide worldwide in 2019: global health estimates. World Health Organization, Geneva, Licence: CC BY-NC-SA 3.0 IGO. 2021. https://apps.who.int/iris/rest/bitstreams/1350975/retrieve
2. World Health Organization (WHO). An implementation guide for suicide prevention in countries executive summary. 2021. Retrieved March 2, 2022, from https://www.who.int/publications/i/item/9789240031029
3. Kim C, The Impacts of Social Protection Policies and Programs on Suicide: A Literature Review. International Journal of Health Services: Planning, Administration, Evaluation, 48(3), 512–534. 2018. https://doi.org/10.1177/0020731418767548
4. World Health Organization (WHO). International Classification of Diseases. ICD. Code R45.851 - Suicidal ideations Retrieved March 2, 2022, from https://icd.codes/icd10cm/R45851
5. Chapman A L, Dixon-Gordon K L. Emotional Antecedents and Consequences of Deliberate Self-Harm and Suicide Attempts. Suicide and Life-Threatening Behavior, 37(5), 543–552. 2007. https://doi.org/10.1521/SULI.2007.37.5.543
6. World Health Organization (WHO). (2014). Preventing suicide: a global imperative. World Health Organization, Geneva.
7. Iemmi V, Bantjes J, Coast E, Channer K, Leone T, McDaid D, Palfreyman A, Stephens B, Lund C. Suicide and poverty in low-income and middle-income countries: a systematic review. The Lancet Psychiatry, 3(8), 774–783. 2016. https://doi.org/10.1016/S2215-0366(16)30066-9
8. Reeves A, McKee M, Basu S, Stuckler D. The political economy of austerity and healthcare: Cross-national analysis of expenditure changes in 27 European nations 1995-2011. Health Policy, 115(1), 1–8. 2014. https://doi.org/10.1016/J.HEALTHPOL.2013.11.008
9. Huikari S, Miettunen J, Korhonen M. Economic crises, and suicides between 1970 and 2011: Time trend study in 21 developed countries. Journal of Epidemiology and Community Health, 73(4), 311–316. 2019. https://doi.org/10.1136/jech-2018-210781
10. Peterson C, Miller G F, Barnett S B L, Florence C. Economic Cost of Injury — United States, 2019. MMWR. Morbidity and Mortality Weekly Report, 70(48), 1655–1659. 2021. https://doi.org/10.15585/MMWR.MM7048A1
11. United Nations (UN). The Sustainable Development Goals (SDGs), 2021 |. Retrieved March 2, 2022, from https://www.un.org/en/desa/sustainable-development-goals-sdgs

12. Milner A, McClure R, de Leo D. Socio-economic determinants of suicide: an ecological analysis of 35 countries. Social Psychiatry and Psychiatric Epidemiology, 47(1), 19–27. 2012. https://doi.org/10.1007/S00127-010-0316-X
13. International Labor Organization (ILO). Social protection: Extending social health protection: Accelerating progress towards Universal Health Coverage in Asia and the Pacific. 2021. Retrieved March 2, 2022, from https://www.ilo.org/asia/publications /WCMS_831137/lang--en/index.htm
14. Hawton K, Heeringen K van. The international handbook of suicide and attempted suicide. 755. 2000. https://books.google.com/books/about/The_International_Handbookof_Suicide_an.html?hl=es&id=swbMhfC2D3AC
15. Durkheim E. Le Suicide. Boyer Séance, J. TD MSCS14C. 1897. Retrieved March 2, 2022, from http://classiques.uqac.ca/classiques/Durkheim_emile/suicide/suicide.html
16. Bearman PS. The social structure of suicide. Sociological Forum 6, 501–524. Ben-Zeev D, Young M [PDF] Semantic Scholar. 1991. Retrieved April 5, 2022, from https://www.semanticscholar.org/paper/The-Social-Structure-of-Suicide1Bearman /b3b72bb 1960927bdf2b329513b6ce73994136b26
17. Chang SS, Stuckler D, Yip P, Gunnell D Impact of 2008 global economic crisis on suicide: time trend study in 54 countries. British Medical Journal 347, 2013. f5239
18. ASPIRE: The Atlas of Social Protection - Indicators of Resilience and Equity. The World Bank. Retrieved March 2, 2022, from https://www.worldbank.org/en/data/data topics/aspire
19. Hollander A C, Pitman A, Sjöqvist H, Lewis G, Magnusson C, Kirkbride J B, Dalman C. Suicide risk among refugees compared with non-refugee migrants and the Swedish-born majority population. British Journal of Psychiatry, 217(6), 686–692. 2020. https://doi.org/10.1192/BJP.2019.220
20. The Daily — Suicide among First Nations people, Métis and Inuit (2011-2016): Findings from the 2011 Canadian Census Health and Environment Cohort (CanCHEC). Retrieved March 4, 2022, from https://www150.statcan.gc.ca /n1/daily-quotidien/190628/dq190628c-eng.htm?HPA=1
21. Haas A P, Eliason M, Mays V M, Mathy R M, Cochran S D, D'Augelli A R, Silverman M M, Fisher P W, Hughes T, Rosario M, Russell S T, Malley E, Reed J, Litts D A, Haller E, Sell R L, Remafedi G, Bradford J, Beautrais A L, Clayton P J. Suicide and Suicide Risk in Lesbian, Gay, Bisexual, and Transgender Populations: Review and Recommendations. Journal of Homosexuality, 58(1), 10. 2011. https://doi.org/10.1080 /00918369.2011 .534038

22. Christian C, Hensel L, Roth C. Income Shocks and Suicides: Causal Evidence From Indonesia. The Review of Economics and Statistics, 101(5), 905–920. 2019. https://doi.org/10.1162/REST_A_00777
23. The World Bank. Current health expenditure per capita (current US$) | Data. 2019. Retrieved April 5, 2022, from https://data.worldbank.org/indicator/SH.XPD.CHEX .PC.CD?locations=XO
24. World Health Organization (WHO). Comprehensive Mental Health Action Plan 2013-2030. 2013. Retrieved March 2, 2022, from https://www.who.int/publications/ i/item /9789240031029
25. World Health Organization (WHO). Thirteenth general program of work 2019–2023. 2019. Retrieved April 6, 2022, from https://www.who.int/publications/i/item /thirteenth-general-programme-of-work-2019-2023
26. World Development Indicators (WDI) - The World by Income and Region. The World Bank. Retrieved April 6, 2022, from https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html
27. Jyoti U D. Multivariate Analysis of COVID-19 for Countries with Limited and Scarce Data: Examples from Nepal | Academia.edu. 2021. Retrieved April 6, 2022, from https://www.academia.edu/54478357/Multivariate_Analysis_of_COVID_19 _for_Countries_with_Limited_and_Scarce_Data_Examples_from_Nepal
28. Institute for Global Health of Barcelona (ISGLOBAL). Health Impact Assessment. Retrieved March 2, 2022, from https://www.isglobal.org/en/health-impact-assessment
29. World Health Organization (WHO). Global health estimates: Leading causes of death. The Global Health Observatory. Retrieved April 6, 2022, from https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death
30. Institute for Health Metrics and Evaluation (IHME). Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Results. Seattle, United States. 2020. Retrieved from http://ghdx.healthdata.org/gbd-results-tool.
31. Institute for Health Metrics and Evaluation (IHME) |. University of Washington, US. Retrieved March 4, 2022, from https://www.healthdata.org/
32. ASPIRE: The Atlas of Social Protection. Data sources and methodology. The World Bank. Retrieved June 6, 2022, from https://www.worldbank.org/en /data/datatopics/aspire /documentation
33. Angrist D J, Pischke J S. Mostly Harmless Econometrics: An Empiricist's Companion. Massachusetts Institute of Technology and The London School of Economic. March

2008. Retrieved May 25, 2022, from https://www.researchgate.net /publication/51992844_Mostly_Harmless_Econometrics_An_Empiricist's_Companion

34. Stata for Windows | Stata. Stata/BE Edition. Retrieved April 6, 2022, from https://www.stata.com/products/windows/
35. Alves F J O, Machado D B, Barreto M L. Effect of the Brazilian cash transfer programme on suicide rates: a longitudinal analysis of the Brazilian municipalities. Social Psychiatry and Psychiatric Epidemiology 2018 54:5, 54(5), 599–606. 2018. https://doi.org/10.1007/S00127-018-1627-6
36. Arellano M, Honoré B. Chapter 53 Panel data models: some recent developments. Handbook of Econometrics, 5, 3229–3296. Elsevier. 2001. https://doi.org/10.1016/S1573-4412(01)05006-1
37. Mccord A, Cherrier C, Both N, Bastagli F. Official development assistance (ODA) financing for social protection Lessons from the Covid-19 response. 2021. Retrieved April 6 from www.odi.org/en/publications/officialdevelop ment-assistance-financing-for-social-
38. Yur'yev A, Värnik A, Värnik P, Sisask M, Leppik L. Role of social welfare in European suicide prevention. International Journal of Social Welfare, 21(1), 26–33. 2012. https://doi.org/10.1111/J.1468-2397.2010.00777.X
39. Victora C G, Joseph G, Silva I C M, Maia F S, Vaughan J P, Barros F C, Barros A J D. The inverse equity hypothesis: Analyses of institutional deliveries in 286 national surveys. American Journal of Public Health, 108(4), 464–471. 2018. https://doi.org/10.2105/AJPH.2017.304277
40. Vijayakumar L, Pathare S, Jain N, Nardodkar R, Pandit D, Krishnamoorthy S, Kalha J, Shields-Zeeman L. Original research: Implementation of a comprehensive surveillance system for recording suicides and attempted suicides in rural India. BMJ Open, 10(11). 2020. https://doi.org/10.1136/BMJOPEN-2020-038636
41. Dandona R, Kumar G A, Dhaliwal R S, Naghavi M, Vos T, Shukla D K, Vijayakumar L, Gururaj G, Thakur J S, Ambekar A, Sagar R, Arora M, Bhardwaj D, Chakma J K, Dutta E, Furtado M, Glenn S, Hawley C, Johnson S C, Dandona L. Gender differentials and state variations in suicide deaths in India: the Global Burden of Disease Study 1990–2016. The Lancet Public Health, 3(10), e478–e489. 2018. https://doi.org/10.1016/S2468-2667(18)30138-5
42. Wei S, Yan H, Chen W, Liu L, Bi B, Li H, Hou J, Tan S, Chen X, Dong G, Qin X. Gender-specific differences among patients treated for suicide attempts in the emergency departments of four general hospitals in Shenyang, China. General Hospital Psychiatry, 35(1), 54–58. 2013. https://doi.org/10.1016/J.GENHOSPPSYCH.2012.10 .007

43. Fresán A, González-Castro T B, Peralta-Jiménez Y, Juárez-Rojop I, Pool-García S, Velázquez-Sánchez M P, López-Narváez L, Tovilla-Zárate C A. Gender differences in socio-demographic, clinical characteristics, and psychiatric diagnosis in/of suicide attempters in a Mexican population. Acta Neuropsychiatrica, 27(3), 182–188. 2015. https://doi.org/10.1017/NEU.2015.6
44. Parameshwaraiah S T, Manohar S, Thiagarajan K. Suicide attempts and related risk factors in patients admitted to tertiary care centre in south india. Journal of Evolution of Medical and Dental Sciences, 7(25), 2916–2920. 2018. https://doi.org/10.14260/JEMDS/2018/657
45. Aghanwa H. The determinants of attempted suicide in a general hospital setting in Fiji Islands: a gender-specific study. General Hospital Psychiatry, 26(1), 63–69. 2004. https://doi.org/10.1016/J.GENHOSPPSYCH.2003.07.003
46. Suicide in Myanmar: the hanging question | The Myanmar Times. Retrieved May 3, 2022, from https://www.mmtimes.com/news/suicide-myanmar-hanging-question.html
47. Promta S, Thomyangkoon P. A Buddhist perspective on suicide. Oxford Textbook of Suicidology and Suicide Prevention, 31–40. Oxford University Press. 2021. https://doi.org/10.1093/MED/9780198834441.003.0005
48. Mars B, Burrows S, Hjelmeland H, Gunnell D. Suicidal behaviors across the African continent: A review of the literature. BMC Public Health, 14(1), 1–14. 2014. https://doi.org/10.1186/1471-2458-14-606/TABLES/5
49. Kootbodien T, Naicker N, Wilson K S, Ramesar R, London L. Trends in Suicide Mortality in South Africa, 1997 to 2016. International Journal of Environmental Research and Public Health, 17(6). 2020. https://doi.org/10.3390/IJERPH17061850
50. Gunnell D, Middleton N, Whitley E, Dorling D, Frankel S. Why are suicide rates rising in young men but falling in the elderly? - A time-series analysis of trends in England and Wales 1950-1998. Social Science and Medicine, 57(4), 595–611. 2003. https://doi.org/10.1016/S0277-9536(02)00408-2
51. Kumar P N S, Anish P K, George B. Risk factors for suicide in elderly in comparison to younger age groups. Indian Journal of Psychiatry, 57(3), 249–254. 2015. https://doi.org/10.4103/0019-5545.166614
52. Dana G S. Indian women a third of world's female suicides | News | Harvard T.H. Chan School of Public Health. 2018. Retrieved June 8, 2022, from https://www.hsph.harvard.edu/news/hsph-in-the-news/india-women-suicide/
53. Bradshaw M, Gericke H, Coetzee B J, Stallard P, Human S, Loades M. Universal school-based mental health programmes in low- and middle-income countries: A systematic review and narrative synthesis. Preventive Medicine, 143, 106317. 2021. https://doi.org/10.1016/J.YPMED .2020.106317

54. Levi-Belz Y, Gvion Y, Apter A. Editorial: The Psychology of Suicide: From Research Understandings to Intervention and Treatment. Frontiers in Psychiatry, 10(APR). 2019. https://doi.org/10.3389/FPSYT.2019.00214

LIST OF APPENDICES

Appendix 1. Analysis and best model fit between Poisson model and negative binomial model

Total population (n=81)	Suicide mortality rates (per 100 000 population)*					
	Poisson Model			NB Model		
	IRR (95% CI)	SE	P>|z|	IRR (95% CI)	SE	P>|z|
Coverage of SP programs (%)	0.83 (0.74 - 0.94)	0.05	0.003	0.83 (0.74 - 0.94)	0.05	0.003
Depressive disorders (%)	0.84 (0.71 – 1.00)	0.05	0.043	0.84 (0.71 – 1.00)	0.05	0.043
Age dependency ratio (%)	0.99 (0.99 - 1.00)	<0.01	0.518	0.99 (0.99 - 1.00)	<0.01	0.518
Health expenditure (%)	0.98 (0.98 - 1.00)	<0.01	0.026	0.98 (0.98 - 1.00)	<0.01	0.026
Unemployment (%)	1.00 (1.00 - 1.01)	<0.01	0.391	1.00 (1.00 - 1.01)	<0.01	0.391
Literacy rate (%)	0.99 (0.98 - 1.00)	<0.01	0.000	0.99 (0.98 - 1.00)	<0.01	0.000
Interpersonal violence (%)	1.04 (0.90 - 1.21)	0.08	0.670	1.04 (0.90 - 1.21)	0.08	0.670
Gini index (%)	1.00 (1.00 - 1.01)	<0.01	0.080	1.00 (1.00 - 1.01)	<0.01	0.080
Model fit**						
AIC	6201.98			6203.98		
BIC	6245.10			6252.49		

IRR: Incidence-rate ratio; 95%CI: 95% confidence interval; RSE: robust standard errors; P>|z|: p-value

Coverage of SPL programs (% of total population), depressive disorders (% all ages), interpersonal violence (% all ages), age dependency ratio (% of working-age population) current health expenditure (% of GDP), unemployment (% of total labor force), adult literacy rate (% of people over 14 years) and Gini Index

*Age-standardized rates

**Best fit for the model with lowest score in the AIC and BIC test (36)

Appendix 2. Sensitivity analyses with categorized effects of SPL programs on suicide mortality rates for the total population (n=81 LMIC), period 2000 to 2019.

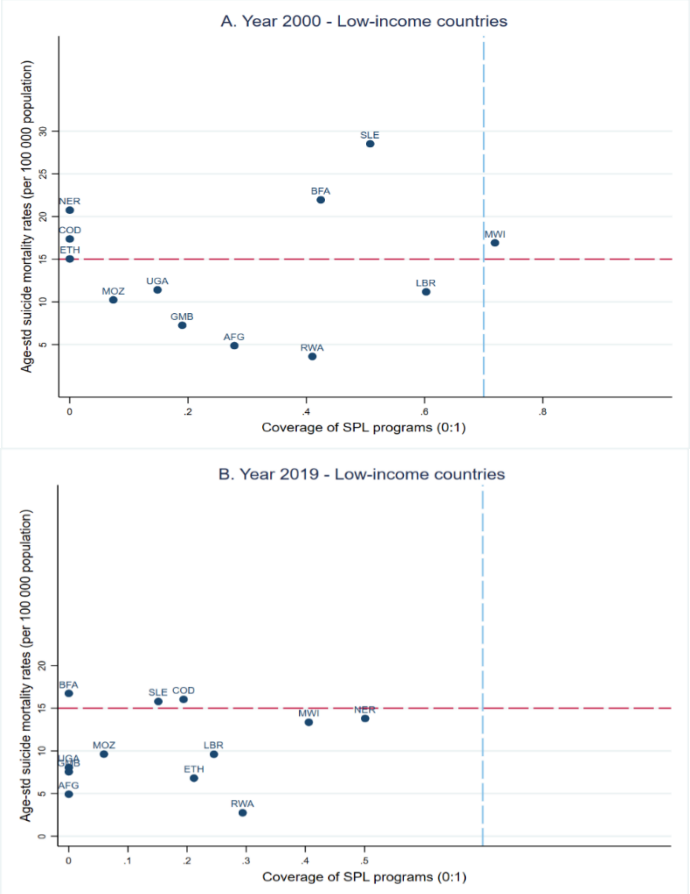
Coverage of SPL programs (%)*	Suicide mortality rates** (per 100 000 population)		
	IRR	P>|z|	95%CI
Total population			
Low coverage (0-29%)	1.00	—	—
Intermediate coverage (30-69%)	0.95	0.140	0.88 - 1.00
Consolidate coverage (70-100%)	0.92	0.040	0.84 – 0.99
SEH variables			
Depressive disorders	0.95	0.070	0.90 - 1.00
Age dependency ratio	1.07	0.216	0.96 - 1.20
Health expenditure	0.94	0.122	0.87 - 1.02
unemployment	1.02	0.398	0.96 - 1.10
Adult literacy rate	0.94	0.000	0.91 - 0.97
Interpersonal violence	1.05	0.124	0.99 - 1.10
Gini Index	1.03	0.325	0.97 - 1.09

*(%) of total population. SPL categorized in 3 groups by % of total coverage: low coverage (0-29%), intermediate coverage (30-69%), consolidate coverage (70%-100%). Categorization of coverage levels are based on previous literature (35)

**Dichotomized by the median value. Values shown for median value or more.

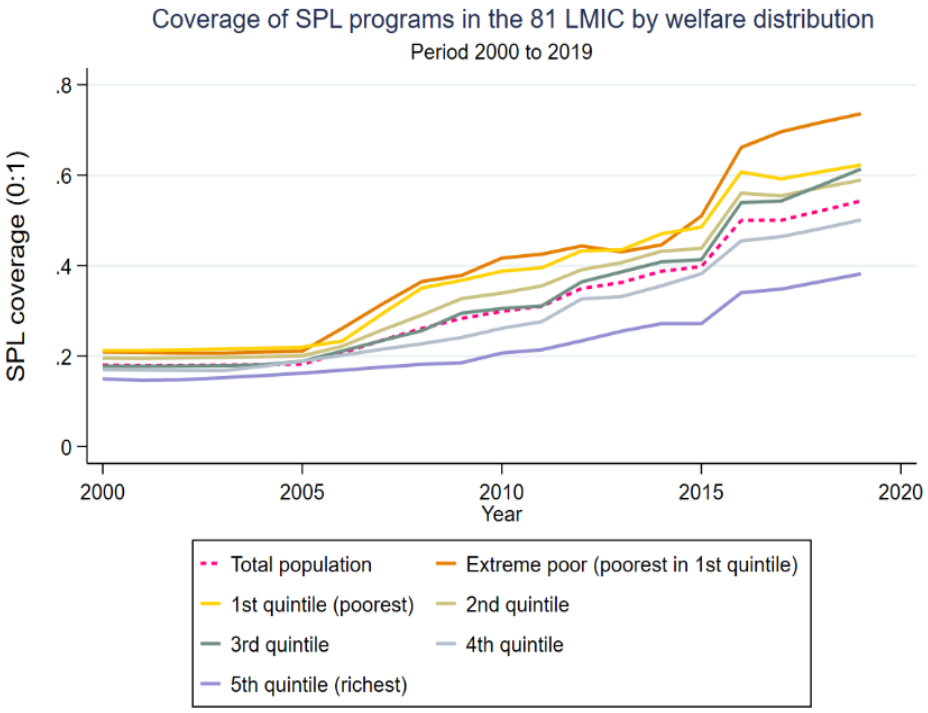
**Adjusted by all covariates: depressive disorders (all ages %), interpersonal violence (all ages %), age dependency ratio (% of working-age population) current health expenditure (% of GDP), unemployment (% of total labor force), adult literacy rate (% of people over 14 years) and Gini Index

Appendix 3. Scatterplots. Comparison of suicide mortality rates (per 100 000 population) and proportion of SPL programs coverage (0:1) in low-income countries (n=12) between 2000 and 2019



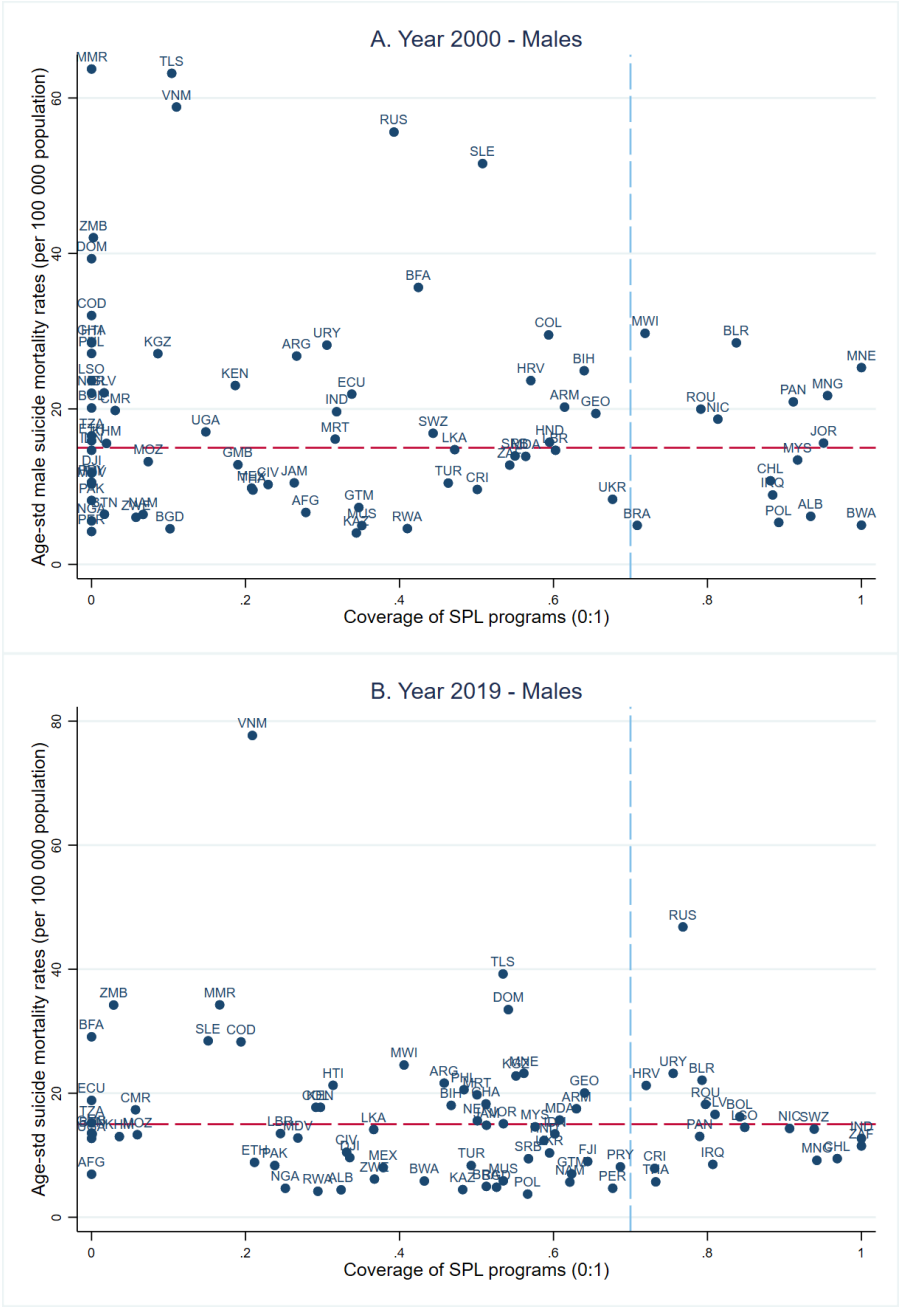
Note: Figure (A): Onset of study in the year 2000; Figure (B): end of the follow-up period in 2019. Horizontal line (red) refers to the threshold rate of high suicide deaths (15 per 100 000 population). Vertical line (blue) shows the cut-point for a consolidated (70% or more) coverage of SPL programs

Appendix 4. Evolution of SPL coverage in the 81 LMIC by welfare distribution quintiles, period 2000-2019



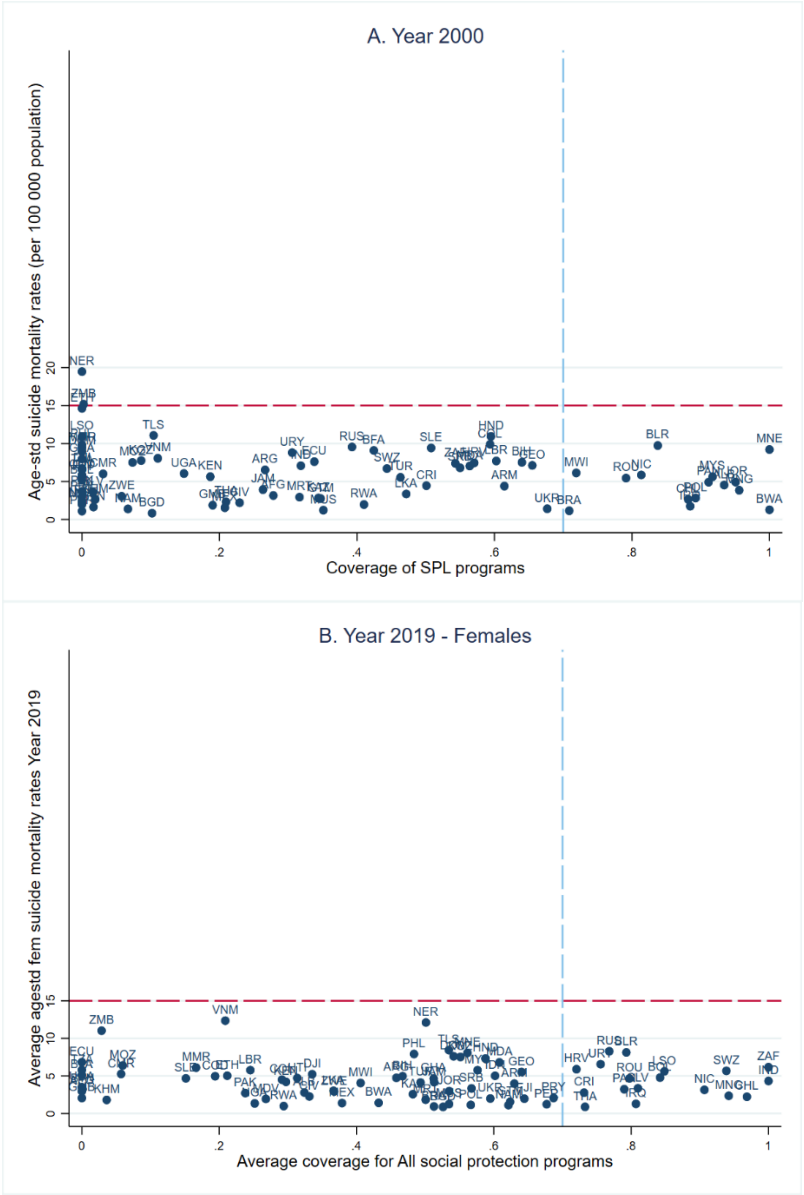
Coverage as a proportion of total population covered by SPL programs (0:1)

Appendix 5. Scatterplots. Comparison of male suicide mortality rates (per 100 000 population) and proportion of SPL programs coverage (0:1) between the onset of study in 2000 (A) and the end in 2019 (B)



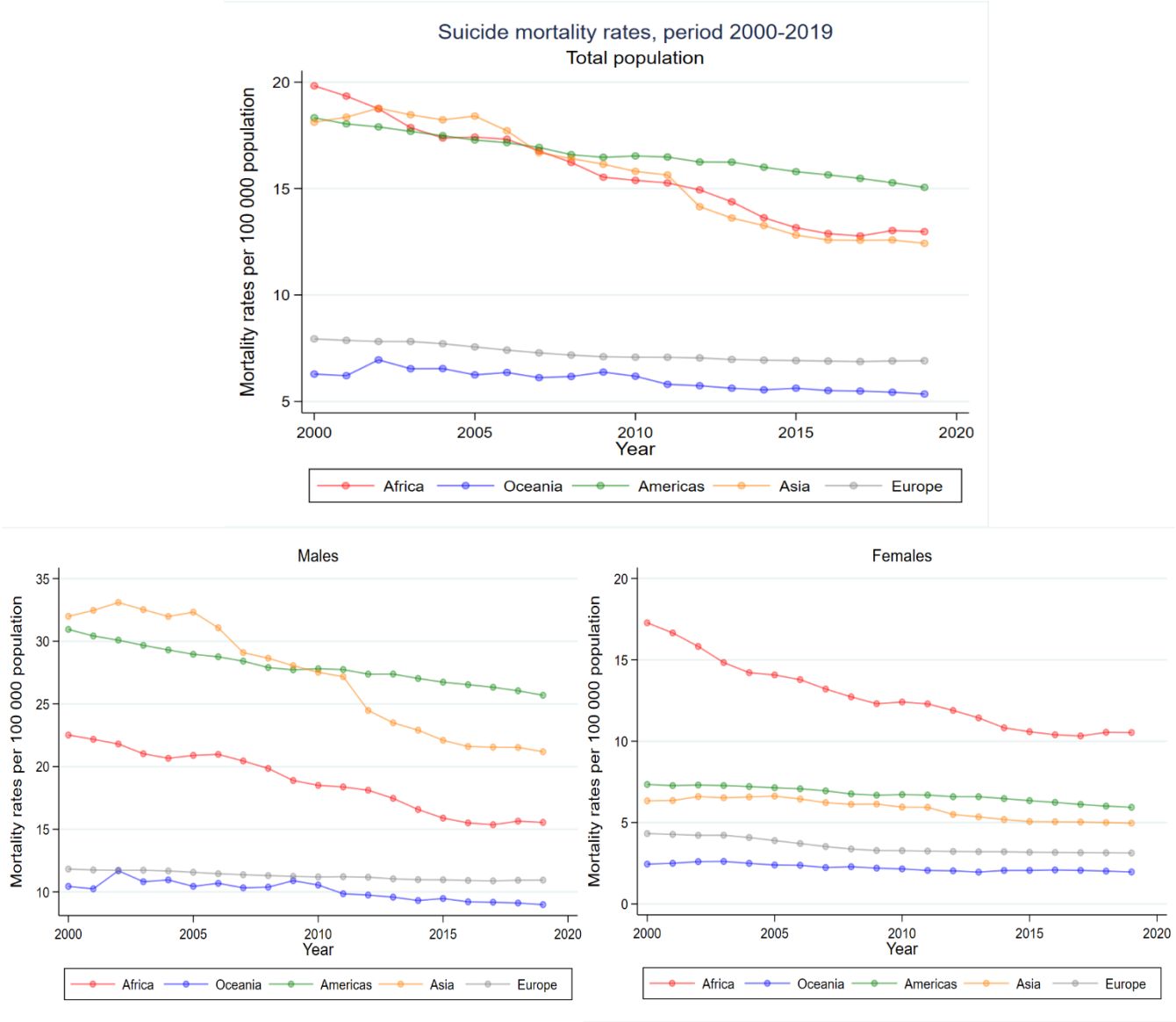
Note: Figure (A): Onset of study in the year 2000; Figure (B): end of the follow-up period in 2019. Horizontal line (red) refers to the threshold rate of high suicide deaths (15 per 100 000 population). Vertical line (blue) shows the cut-point for a consolidated (70% or more) coverage of SPL programs

Appendix 6. Scatterplots. Comparison of female suicide mortality rates (per 100 000 population) and proportion of SPL programs coverage (0:1) between the onset of study in 2000 (A) and the end in 2019 (B)



Note: Figure (A): Onset of study in the year 2000; Figure (B): end of the follow-up period in 2019. Horizontal line (red) refers to the threshold rate of high suicide deaths (15 per 100 000 population). Vertical line (blue) shows the cut-point for a consolidated (70% or more) coverage of SPL programs

Appendix 7. Evolution of total and sex-specific (male, female) suicide mortality trends by WHO region for the 81LMIC, period 2000- 2019



Age-standardized mortality rates for the total population (n=81)
Regions as classified by WHO

ABSTRACT (FRENCH)

Contexte: Les données sur le suicide sont principalement basées sur les pays à revenus élevés. Or, plus de 77 % du total des décès par suicide surviennent dans les pays à faible et moyen revenus (PFMR). Les interventions en matière de protection sociale et de travail (SPL), visant à atténuer les effets des inégalités socio-économiques et de la pauvreté, pourraient influencer les comportements suicidaires.

Objectif: Explorer les effets des programmes de protection sociale et de travail (SPL) sur les taux de mortalité par suicide dans 81 pays à faible et moyen revenus entre 2000 et 2019.

Méthodes: Les taux bruts de mortalité par suicide normalisés selon l'âge ont été analysés à l'aide de regressions de Poisson à effet fixe et erreurs types robustes, ajustés par facteurs socioéconomiques et sanitaires. Les données ont été obtenues à partir du Global Social Epidemiology Dataset (ISGlobal, Espagne), intégrant des informations provenant de l'IHME-GBD, de l'OMS-GHE et de la Banque mondiale. La variable SPL a été mesurée en utilisant l'indicateur de couverture tel que défini par ASPIRE. Les effets de la couverture SPL ont été testés en utilisant les données de 81 PFMR sur la période 2000-2019.

Résultats: Les résultats suggèrent des effets protecteurs potentiels des programmes SPL sur la réduction des taux de mortalité par suicide de la population globale dans 81 PFMR pour la période 2000-2019. Les dépenses de santé actuelles et les troubles dépressifs étaient associés à une réduction des taux de mortalité par suicide dans la population globale. Les résultats des analyses stratifiées par sexe, âge, répartition de la richesse et niveau de revenu ont suggéré des effets protecteurs similaires dans la plupart des catégories comme pour la population globale.

Conclusions: Les résultats de cette étude suggèrent que la mise en œuvre de programmes de SPL pourrait avoir des effets protecteurs contre la mortalité par suicide dans 81 PFMR entre 2000 et 2019. Une prise en compte des particularités contextuelles de chaque pays pourrait permettre de cibler des interventions sociales efficaces contre le suicide, d'où la necessité d'envisager des études qualitatives dans ce but. D'autres études au niveau de la population et de l'individu sont nécessaires dans les PFMR pour renforcer cette preuve.

Mots clés: Protection sociale, suicide, revenu faible et moyen, déterminants de la santé, données de panel, effets fixes.