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The socioeconomic burden of migraine in China, Japan, South Korea, and Taiwan

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List of Abbreviations

DALY	Disability-adjusted life year
FCA	Friction cost approach
GBD	Global burden of disease
GDP	Gross domestic product
GVA	Gross value added
HCA	Human capital approach
IHME	Institute for Health Metrics and Evaluation
IO	Input-output
NACE Rev. 2	Second revision of the Statistical Classification of Economic Activities in the European Community
OECD	Organization for Economic Cooperation and Development
SOB	Socioeconomic burden
USES	Unpaid substitution economic sector
YLD	Years lost due to disability
YLL	Years of life lost



Summary

Objective

Strong evidence exists for the relationship between individual productivity and health. Consequently, disease directly affects the number and ability of productive workers, which in turn influences economic growth. This effect of disease on productivity is captured in the concept of socioeconomic burden (SOB). A disease with a high burden that predominantly affects women in their most productive ages is migraine. The aim of this report is to study the overall and gender specific SOB of migraine in China, Japan, South Korea, and Taiwan, and contextualize this burden relative to diabetes and cardiovascular diseases.

Method

We adopted an innovative method that integrates input-output analysis of value chain effects with health economics to explore how health investments stimulate economic growth by improving population health. A healthier population not only brings direct advantages but also triggers spillover effects across related economic sectors and induces further impacts along value chains. Our analysis considered productivity gains from health improvements in both paid and unpaid work, treating years lost to disability or premature death as unproductive. To quantify these effects, we used years lived with disability (YLDs) to assess presenteeism and absenteeism, and productive years of life lost (YLLs) to evaluate productivity losses due to mortality.

Results

The total SOB of migraine, which includes lost productivity of both paid and unpaid work, ranges from 1.23% of the GDP of Japan to 2% of the GDP of China in 2021. Between 2011 and 2021, this translates into economic losses ranging from 121 billion US\$ in Taiwan to 2.665 billion US\$ in China. In 2021, the SOB of migraine is similar to diabetes (ranging from 1.68% of the GDP of Japan to 3.13% of the GDP in South Korea) and cardiovascular diseases (ranging from 1.13% of the GDP of Japan to 1.95% of the GDP of China), thus showing the high SOB of migraine. In terms of gender differences, the productivity of women is more affected than that of men. The smallest difference is found in China, where in 2021 the SOB of migraine is 0.74% of the GDP in men and 1.26% of the GDP in women. The largest difference in the total SOB is found in Japan, where the burden of migraine is 0.38% of the GDP in men and 0.85% of the GDP in women.

Conclusion

The SOB of migraine is substantial across the four studied countries, affecting both paid and unpaid work productivity. Women disproportionately bear this burden, with gender inequalities in unpaid work contributing to significant productivity losses in this domain. Since unpaid work includes critical activities such as caregiving, addressing the burden of migraine could not only enhance productivity across both paid and unpaid sectors but also reduce strain on government budgets by lessening the reliance on public support systems.



1

Introduction

Migraine is a neurovascular disorder that is defined by reoccurring moderate to severe headache (Goadsby, 2007). Globally, it has been estimated to have a prevalence of 14% in 2019, which translates to 1.1 billion people being affected (Amiri *et al.*, 2022). Due to the severity of headaches, this results in a heavy disease burden. In the Global Burden of Disease (GBD) study, it is estimated that migraine ranks second in terms of disease burden amongst all diseases with respect to years lived with disability (IHME, 2024a). A notable observation is that this burden is increasing over time. Between 1990 and 2021, the global prevalence increased by 39.52% (Chen *et al.*, 2024). It should also be observed that younger women are particularly affected. The global prevalence for women between the age of 40 and 44 showed the highest prevalence of disease in 2021, equivalent to 27,458 per 100,000 women (IHME, 2024b).

Besides this disease burden, migraine also results in high costs to the healthcare system. A systematic review by Eltrafi *et al.* (2023) estimated the direct costs of migraine to the healthcare system in the organization for economic co-operation and development (OECD) countries. Costs include physician or hospital visits, the cost of drugs, etc. This study shows that in OECD countries, the annual estimated direct cost per patient ranges from £1,754.52 to £8,219.46 in the 13 different articles that they identified. Considering the high prevalence of migraine, these high per patient costs result in a significant aggregated cost to the healthcare system.

Beyond the impact of migraine on the health burden of a population and disease related cost to the healthcare system, there is an additional cost of migraine when the relationship between health and economic productivity is considered (Suhrcke *et al.*, 2006; Jamison *et al.*, 2013; Bloom, Kuhn and Prettnner, 2019). This relationship can be explained by the reduced productivity of a population that is more affected by disease (Shimizu *et al.*, 2021). To research these broader costs, a socioeconomic burden (SOB) of disease study can be conducted. The SOB of disease describes how disease impairs labor supply, by reducing the ability of individuals to use their human capital.

The SOB of a disease in a country can be assessed by studying the effects of a disease's mortality and morbidity on productivity. Mortality reduces the number of people who are able to work, thus directly affecting labor supply. Additionally, mortality results in the need to recruit new employees in the case of paid work. This also results in productivity losses, due to the time it takes to onboard new employees. Additionally, morbidity results in presenteeism and absenteeism. Due to living with the burden of a disease, presenteeism is the result of working while sick, leading individuals to become less productive at work. In the worst case, individuals might face temporary unplanned absences from work because of the disease, also known as absenteeism.

Particularly in the case of migraine, the SOB of disease can be high, since it predominantly affects younger women, therefore in their most productive life cycle. To illustrate this, an earlier study conducted at WifOR by Seddik *et al.* (2020) researched exactly these costs. In this study, which focused on Germany, it was estimated that the annual cost of productivity losses resulting from migraine can amount to €6,493 per patient, a total cost of more than €100 billion per year in Germany.

Despite these high, broader societal costs, Eltrafi *et al.* (2023) found that most studies focus on the direct costs while the broader costs of migraine to society remain understudied. Particularly, no evidence was identified for Asia, which is striking. Due to the large population sizes of Asian countries, most of the disease burden of migraine can be attributed to the Asian continent (IHME, 2024b).

The aim of this report is therefore to describe the SOB of migraine in China, Japan, South Korea and Taiwan. More specifically the study will:

- Describe the SOB of migraine
- Compare the SOB of migraine with cardiovascular disease and diabetes
- Conduct a gender specific analysis on the SOB of migraine



2 Methods

2.1 Analysis

The analysis of the SOB of migraine relates disease burden to productivity losses. This is essentially done in three major stages. In stage (A), the disease burden of migraine is estimated in terms of disability adjusted life years (DALYs). In stage (B), this disease burden is translated into losses in productivity, with a loss of a DALY representing a non-productive year. In stage (C), these lost DALYs are valued in terms of gross value added (GVA). A description of these three stages is provided below, while the detailed formulas to derive the estimates are included in the Annex.

In stage (A), Disease burden is quantified in terms of DALYs. DALYs combine information about mortality and morbidity. Disease burden associated with mortality is expressed in terms of years of life lost (YLL), which reflect how many life years an individual could have lived, if this individual had not died of a certain disease. To illustrate this, an individual who dies at the age of 30 due to a cardiovascular event could have lived up to an expected age of 80, which thus translates into 50 YLL. The disease burden associated with morbidity is reflected with years lived with disability (YLD), which reflect the burden of living with a disability. For instance, someone living with migraine has a disability weight of 0.4, which symbolizes that 80 years of living with migraine is equal to living 48 years of living a healthy life (80 times 1 minus the disability weight), or in other words, 32 years are lost due to living with disability. Combined, it is possible to equate and aggregate disease burden in terms of YLD and YLL. The combination of YLD and YLL is the DALY.

To translate the disease burden into lost productivity in stage (B), we generally assume that any DALY lost reflects a non-productive year. There are however specific differences in how YLL and YLD are related to productivity losses. For YLL, we use two approaches: the human capital approach (HCA) and the friction cost approach (FCA). In the HCA, we assume that the death of an individual results in a loss of productivity that cannot be replaced. In the FCA, we assume that after one year, an organization adapts to the loss of an individual, through for example hiring, or organizational/technological adaptations. In other words, we assume that a death results in a productivity loss of one year. For DALY losses in terms of YLD, we assume similarly that a lost DALY reflects a non-productive year. To illustrate this, a healthy individual without migraine is equally productive as 2.5 individuals with migraine in a year (1 divided by the disability weight). In the case of YLD, we assume that these capture productivity losses due to presenteeism and absenteeism.

In stage (C), we value the losses in productivity through GVA because it is a more comprehensive indicator of economic performance than wages alone. GVA accurately portrays the value contributed by a worker to the overall economy. By considering the effect of GVA on the person employed, we are considering the productivity per capita of an employed person. In this sense, the estimation of the monetary value of the burden of a disease will reflect the effect of reducing the capacity of working of the productive people in the economy.

Moreover, to evaluate the effect of paid work, we use multipliers based on input-output models to not only assess direct costs, but also spillover effects in terms of indirect and induced costs. The direct effects reflect the direct economic impact of a reduction in paid work due to lost health. The indirect effects reflect the losses in intermediate consumption of goods and services, due to a loss of GVA related to disease loss. Induced effects reflect the impact of disease on expenditures from income that is generated both directly and indirectly, with a reduction in income leading to lower consumption. Indirect and induced effects reflect the spillover effects. The total productivity losses in terms of paid work are then calculated by combining the direct, indirect, and induced costs.

The nature of unpaid work is different from paid work in the type of tasks that it encompasses. Examples of such tasks include meal preparation, care taking of household members, or taking care of the household itself. As such, we assume that there is a difference between the value of unpaid work as compared to paid work. Consequently,



we value unpaid work by taking the value of an economic activity that most closely resembles the unpaid activity. Details about this adjustment can be found in the Annex.

To further contextualize the SOB of migraine, we additionally calculate the SOB of cardiovascular diseases and diabetes following the methodology explained above. Lastly, we disaggregate the SOB of migraine by sex, to further study the differences in how migraine affects the paid and unpaid work activity in men and women.

Data

Various datasets are used as inputs for the variables used in our analysis. To estimate disease burden, YLD and mortality are derived from the GBD study for migraine, CVD, and diabetes. Specifically, YLD and mortality was stratified by country, sex, age group, and year. Age groups are defined by 5-year intervals, from the age of 15 to 94, with the oldest age group being 95+.

Time spent on unpaid work covers the average hours per day spent on unpaid domestic work and care. This average per day is based on the full week, thus averaging out time spent on unpaid work during the week and in the weekend. Total time spent on work covers the time spent on both paid and unpaid work. Again, this data is presented as the average hours per day for the full week, including the weekend.

For data related to paid and unpaid working hours of Japan, South Korea, and mainland China, we used data from the United Nations Department of Economic and Social Affairs (UN Statistics Division, 2024a). This data is derived from various time use surveys. This means that it contains survey results from different time points within the same country. For our study, we selected data from the latest survey conducted per country. For Taiwan, we used data from the Survey on Social Development Trends (DGBAS, n.d.b). This data presents time use across different specific categories, such as time used on eating, commuting, or work. We reclassified these categories to paid and unpaid work according to the International Classification of Activities for Time Use Statistics 2016 (UN Statistics Division, 2017). Following this classification, the time spent on work was used as an indicator for paid work, and time spent on housework, taking care of family, educating children, shopping or errands as indicators for time spent on unpaid work.

Lastly, it should be noted that all the data regarding time use was stratified by age and gender.

For the demographic and economic inputs, we also derived data from various sources. For demographic inputs, we used data from the World Bank for China, Japan, and South Korea (World Bank, 2024b). For economic inputs, data from the World bank was used as well, except for GVA in the case of China. Here, we used data from the United Nations (UN Statistics Division, 2024b). For Taiwan, we used data from the national statistical office (DGBAS, n.d.a). A complete overview of the variables and data sources for each variable can be found in Table 2 in the Annex.

To facilitate comparisons regarding the value across countries we used GVA data presented in the value of 2015 US Dollars. For Taiwan, only GVA data for 2016 Taiwanese Dollars was available. We deflated this data to 2015 Taiwanese Dollars with a local CPI based inflator (DGBAS, n.d.a). Then, using an exchange rate from that year, we transformed these 2015 Taiwanese Dollars to 2015 US Dollars (DGBAS, n.d.a).



3

Results

3.1 The socioeconomic burden of migraine

The disease burden of migraine is significant and typically affects younger women. This is shown in Figure 1, which shows the YLD per age group in the four countries. Here, the typical pattern emerges of women having a consistently higher disease burden than men, and this disease burden increasing until the age groups between 45 and 59.

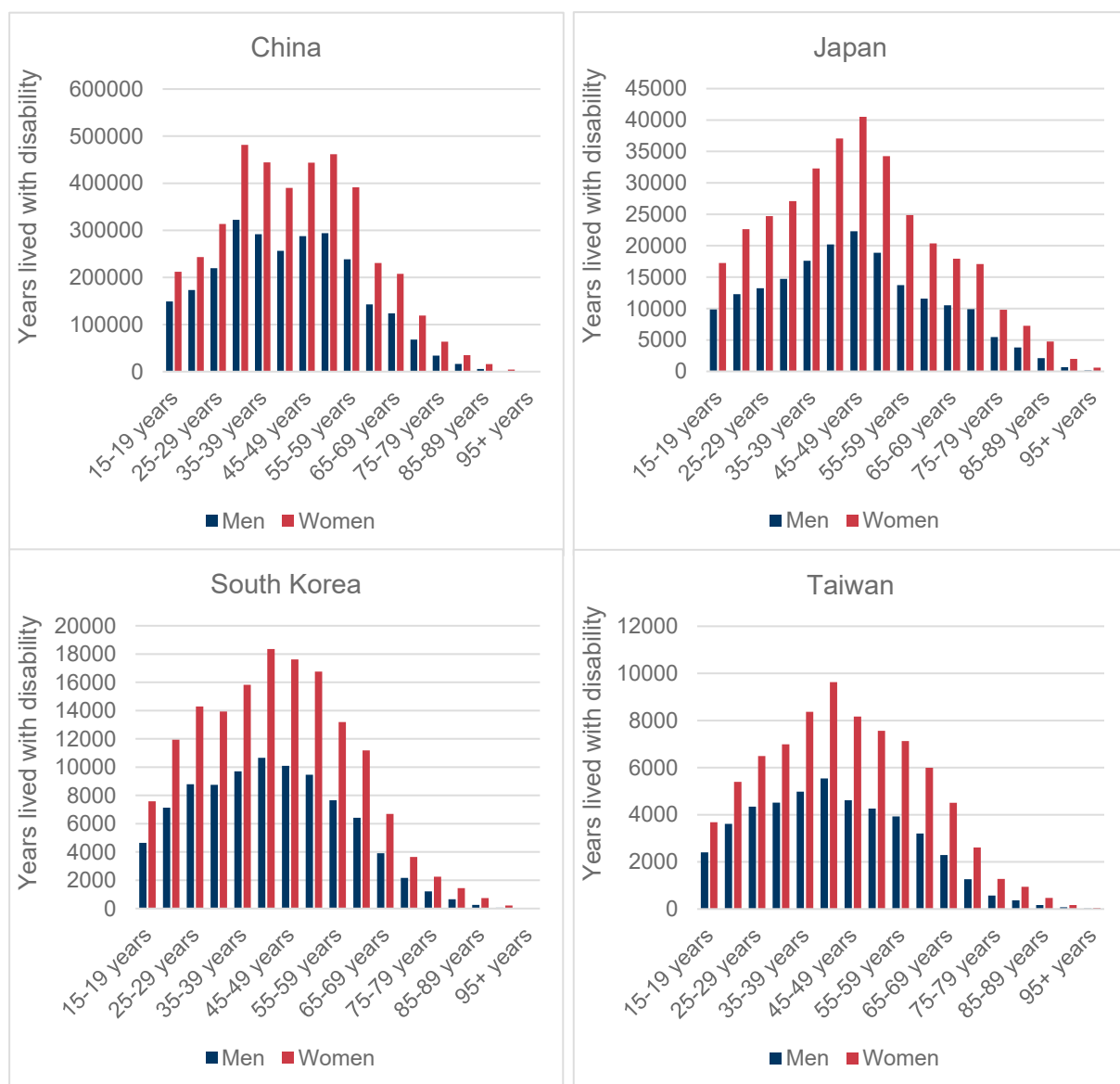


Figure 1. Years lived with disability in the four included countries

The SOB of migraine is significant. In 2021, productivity losses range from 0.42% in Japan to 0.58% in Taiwan in relation to the gross domestic product (GDP) in terms of direct paid work (see Figure 2). This further resulted in indirect and induced productivity losses. In terms of indirect effects, losses range from 0.27% of the GDP in



Japan to 0.94% of the GDP in China. In terms of the induced effects, further losses can be quantified as 0.32% of the GDP in China to 0.84% of the GDP in Taiwan. Translated into 2015 US\$, this result in a combined (direct, indirect, and induced) productivity loss ranging of 12.72 billion US\$ in Taiwan, 25.43 billion USD in South Korea, 55.35 billion US\$ in Japan, and 317 billion US\$ in China. It is important to note that there are no differences in the burden calculated using the FCA and HCA approaches for productivity losses due to mortality, as migraine does not result in mortality.

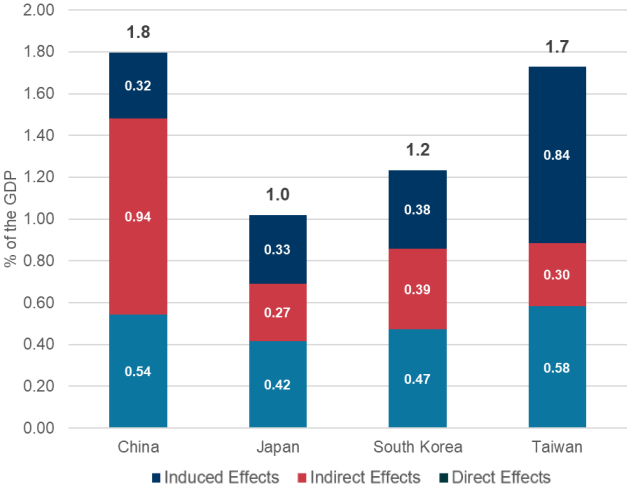


Figure 2. Socioeconomic burden of migraine in terms of direct, indirect, and induced effects in 2021

Beyond burden related to paid work, migraine also results in a heavy burden due to productivity losses in unpaid work. For 2021, these losses are 1.50 billion US\$ in Taiwan to 32.5 billion US\$ in China. In terms of percentage of GDP, when productivity losses of paid and unpaid work are combined, this results in total losses of 1.23% of the GDP of Japan, 1.50% of the GDP in Korea, 1.96% of the GDP in Taiwan and 2.00% of the GDP in China. Migraine thus significantly burdens the productivity of these countries. Figure 3 presents these total losses in billions of 2015 US\$. Here, it is clearly shown that due to the size of its economy, in absolute terms the SOB of migraine particularly affects China, with a total loss equivalent to 317.45 billion US\$.

So far, the SOB of migraine has been described for 2021, thus one year. This SOB is however a yearly drag on the productivity of the country. Figure 3 also shows the total (paid and unpaid) productivity losses of migraine in 2015 US\$ for a period of 10 years – from 2011 to 2021. Here, it should be noted that the SOB of China almost tripled in this period, from 122.44 billion 2015 US\$ in 2011 to 322.75 billion 2015 US\$ in 2021.

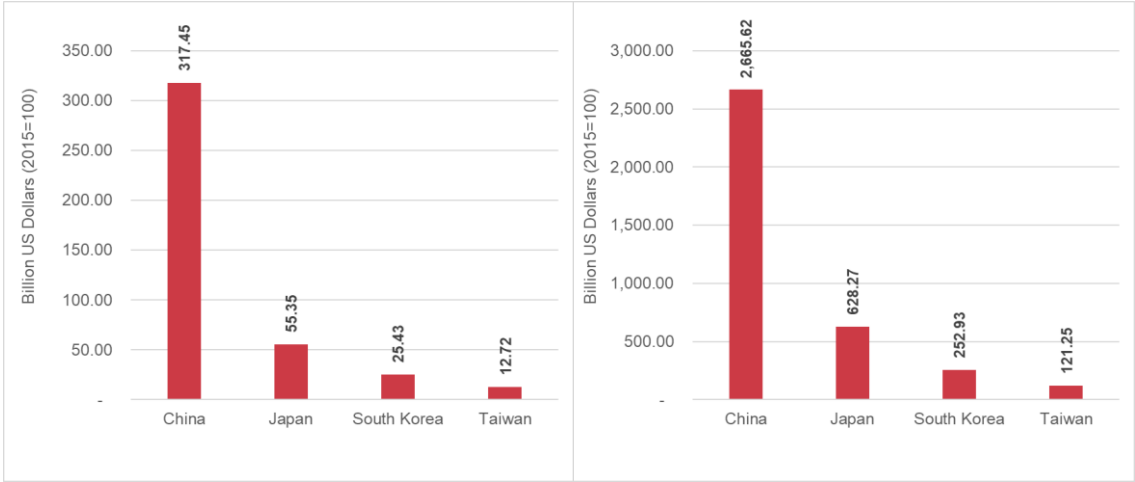


Figure 3. Total socioeconomic burden of migraine in 2021 (left) and between 2011-2021 (right), in 2015 US\$

3.2 The socioeconomic burden of migraine compared with diabetes and cardiovascular diseases

A further comparison of the productivity losses of migraine compared with the productivity losses associated with diabetes and cardiovascular further puts these figures into perspective. Figure 4 shows the SOB of migraine, cardiovascular disease and diabetes in the four countries in terms of direct, indirect, and induced effects. In this figure, productivity losses due to mortality are estimated conservatively with the FCA, or in other words, under the assumption that the productivity of an employee can be replaced in one year. Under this assumption, the SOB of migraine is higher than cardiovascular diseases - migraine shows a SOB equivalent to 1.73% of GDP and cardiovascular diseases having a SOB equivalent to 1.29% of GDP. Figure 5 shows the same figures of the SOB of migraine, cardiovascular disease and diabetes, but with productivity losses due to mortality estimated with the HCA. Given that there is no mortality associated with migraine, the estimates of migraine do not change. However, the SOB of diabetes and cardiovascular diseases increase, resulting in cardiovascular disease having the SOB in each country. Still, even with a less conservative estimate of productivity losses from diabetes-related mortality, the SOB for migraine and diabetes is shown to be similar across countries.



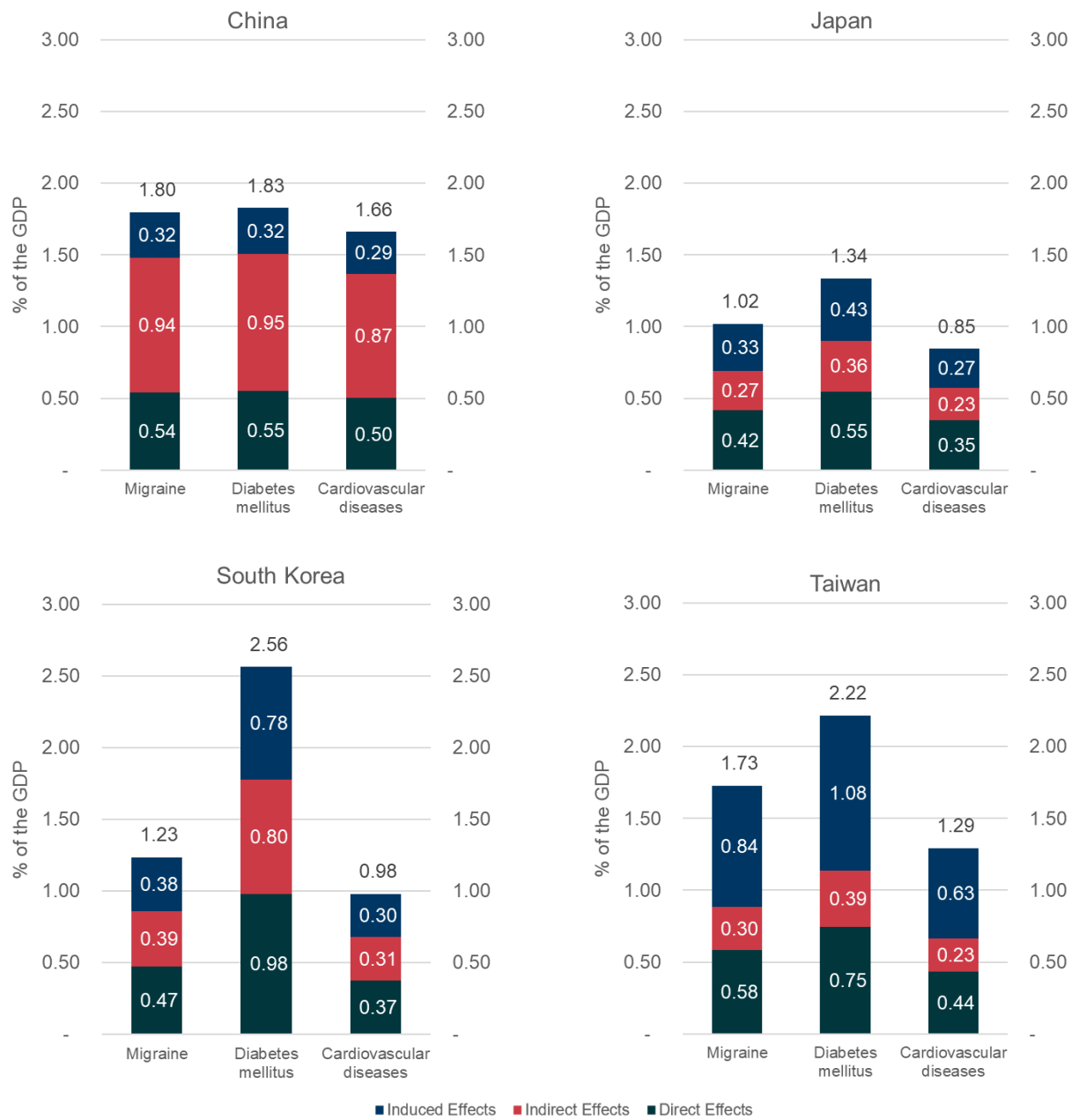


Figure 4. A comparison of the socioeconomic burden of migraine, diabetes, and cardiovascular diseases in terms of direct, indirect, and induced effects under the friction cost approach in 2021



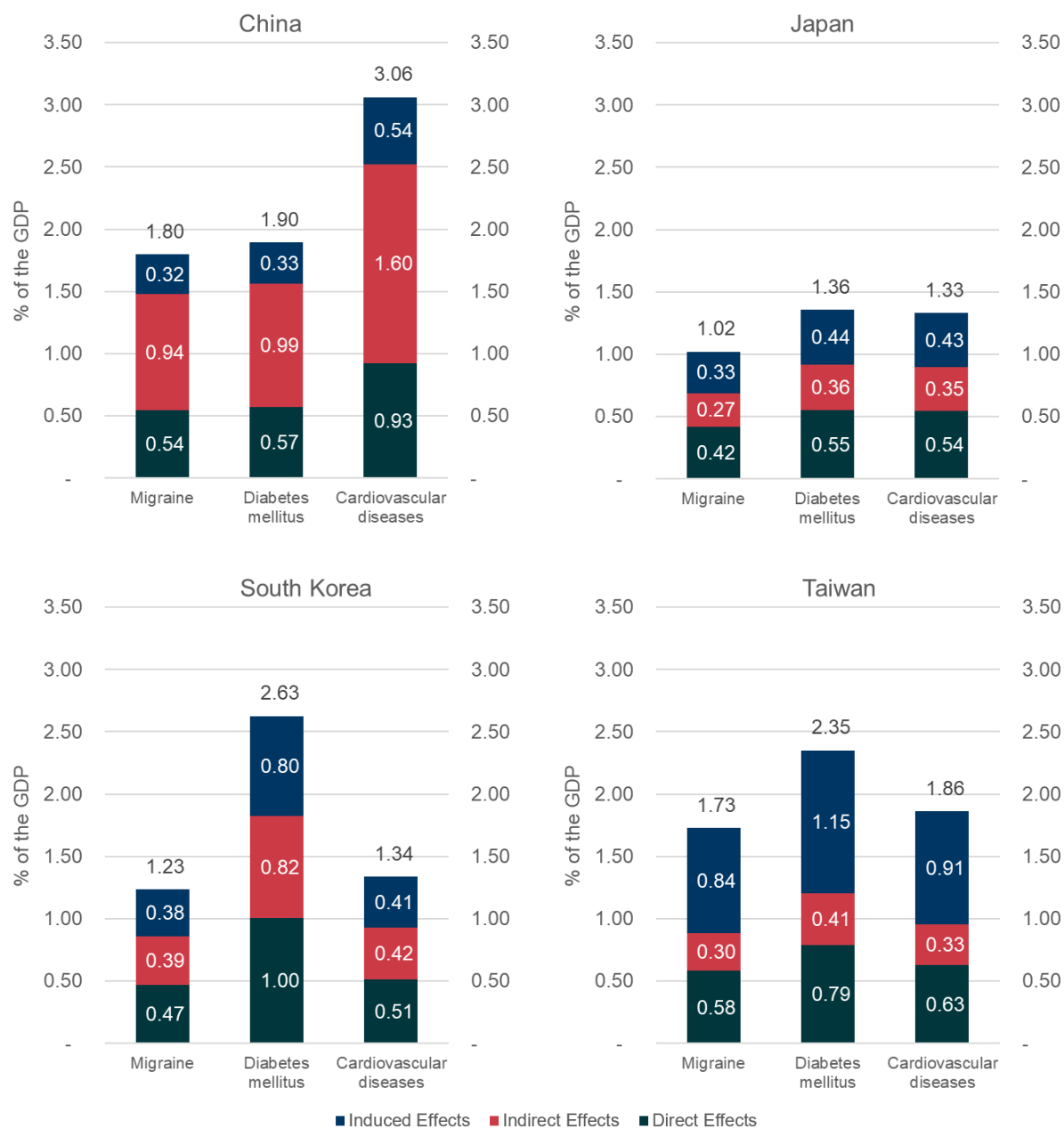


Figure 5. A comparison of the socioeconomic burden of migraine, diabetes, and cardiovascular diseases in terms of direct, indirect, and induced effects under the human capital approach

In Figure 6 the SOB of migraine, diabetes and cardiovascular disease in the period 2011 to 2022 in the different countries is presented. This SOB has been calculated with the conservative FCA estimate for productivity losses related to mortality. The figure shows that particularly the SOB of migraine is stable over time. In absolute terms however there has been a rapid increase in the SOB of migraine and disease in general in Taiwan, China, South Korea, and Japan. The starkest increase in burden in absolute terms can be found in China. Here, the paid work-related SOB of migraine in 2015 US\$ increased from 122 billion 2015 US\$ in 2011 to 263 billion 2015 US\$ in 2021.

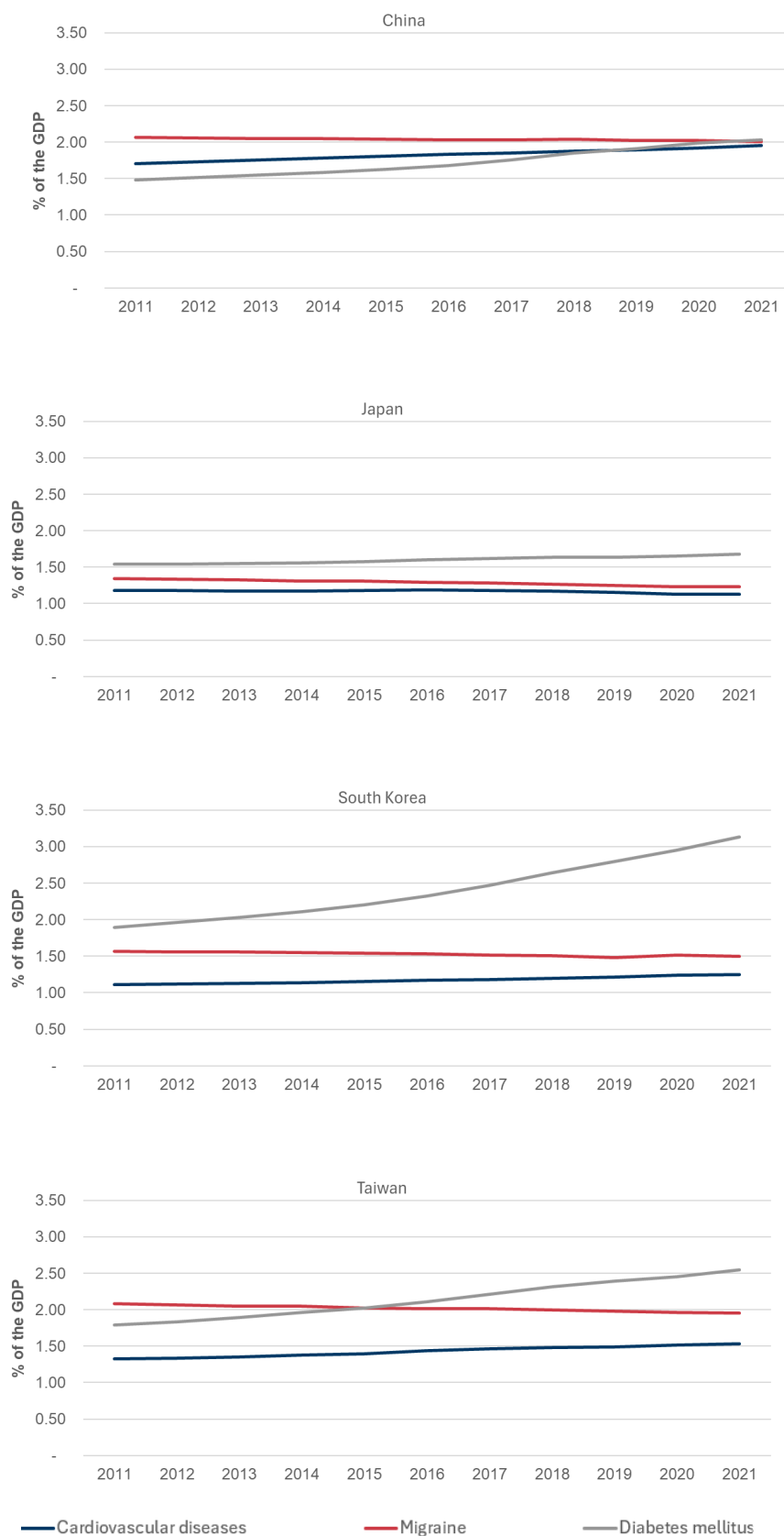


Figure 6. Temporal changes in the socioeconomic burden of migraine, cardiovascular diseases and diabetes as a percentage of GDP, under the friction cost approach



3.3 Gender specific differences in the socioeconomic burden of migraine

Migraine particularly affects younger women (see Figure 1). This means, that the majority of the SOB of migraine can be attributed to women, which is shown in Figure 7. This figure shows productivity losses in absolute terms in 2015 US\$ in 2021. The solid bars show the losses in productivity in terms of paid work, whereas the faded bars show productivity losses in unpaid work. Here, it becomes clear that in South Korea and Japan, the total productivity losses associated with migraine in women is more than two times higher than in men. This is close to two times higher in China and Taiwan. These differences are in part driven because of the higher disease burden of migraine in women when compared to men. Particularly striking is the difference in productivity losses in terms of unpaid work. This is not only driven by the increase in disease burden in women, but also by the unequal share of unpaid work (see Table 1 in the annex for the gender differences in average hours per week spend on paid and unpaid work per country). To illustrate this difference, in China, the lost value in unpaid work productivity is 4.75 billion 2015 US\$. In women, this loss is valued at 27.7 billion 2015 US\$. Figure 7 also presents these losses in terms of the percentage of GDP in 2021 to further contextualize these losses. In this figure, it becomes clearer how much more the productivity of women is affected when compared to men, particularly in terms of lost productivity in unpaid work. Figure 8 provides further context to the SOB of migraine, by showing how the SOB of migraine, diabetes, and cardiovascular disease differently affects men and women over time. Here it is shown that in terms of SOB in women, migraine results in higher losses than cardiovascular disease over all time periods in all countries. Additionally, migraine also showed higher SOB than diabetes in China and Japan. This can be contrasted with the SOB of the diseases in men in the different countries, where migraine is consistently shown to exhibit the lowest SOB, except for the period 2011-2015 in Taiwan.



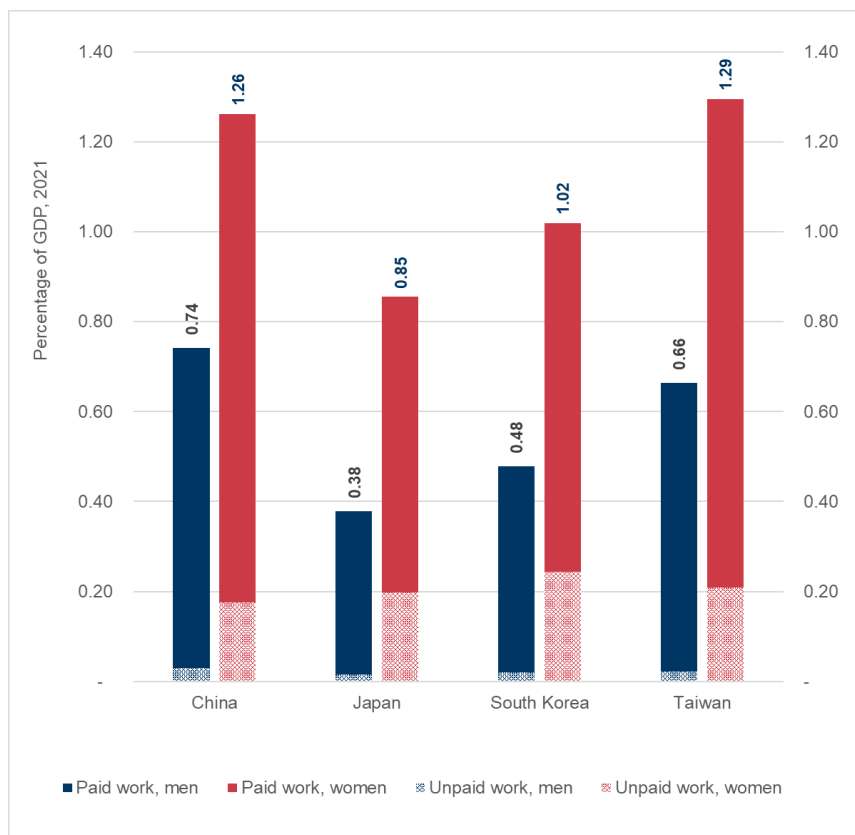
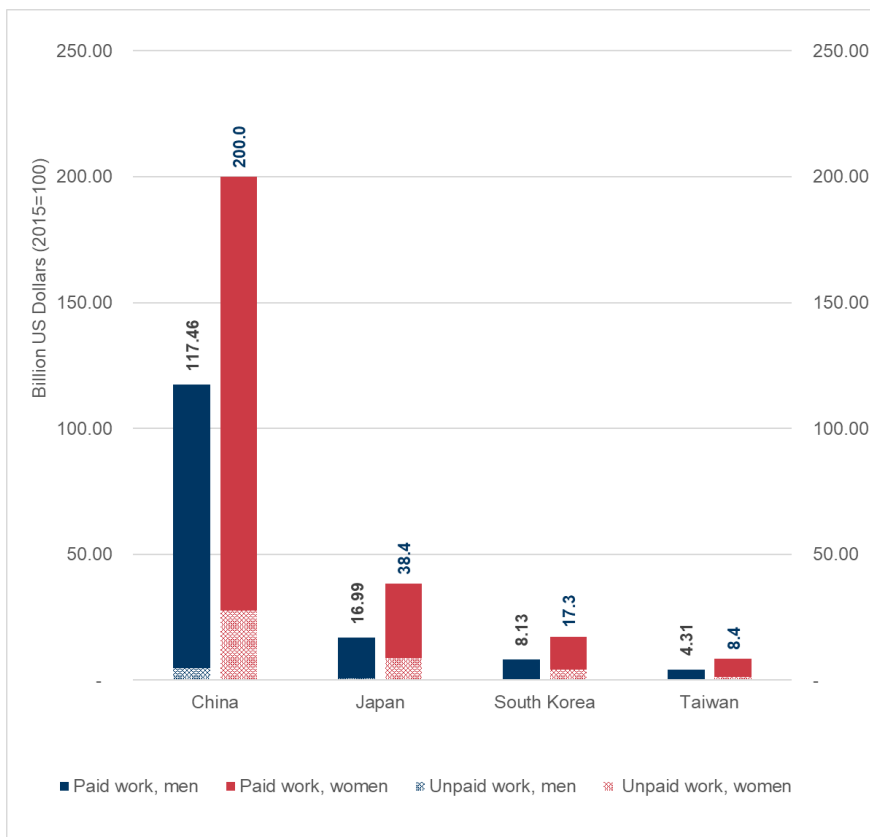


Figure 7. Comparison of the socioeconomic burden of migraine in men and women in 2021 in terms of paid and unpaid work, with the upper graphic presenting this burden in terms of 2015 US\$, and the lower graphic as a percentage of GDP.

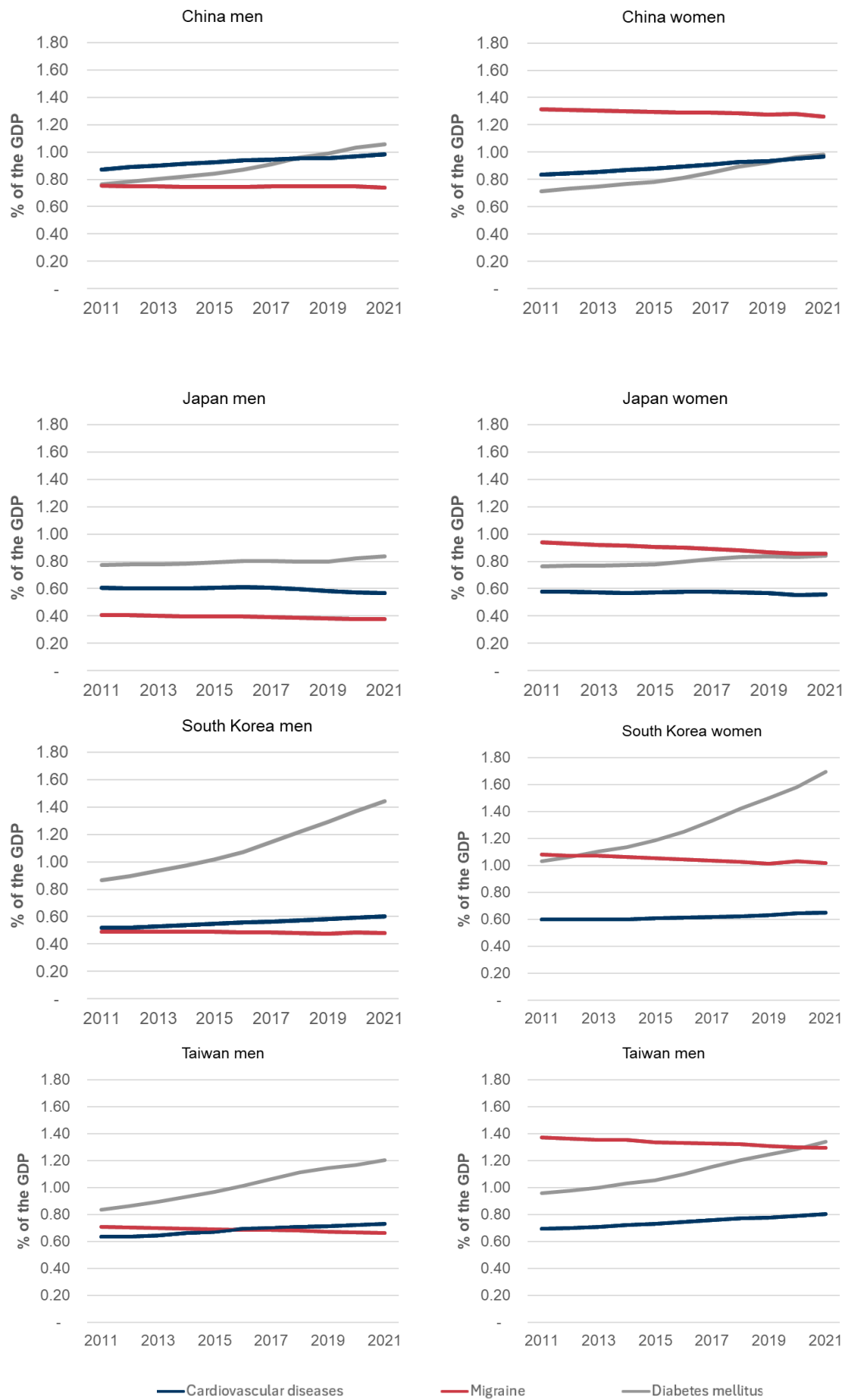


Figure 8. Temporal changes in the socioeconomic burden of migraine, cardiovascular diseases and diabetes, by country and gender, as a percentage of GDP.

4

Discussion

This study shows that the SOB of migraine is high in China, Japan, South Korea and Taiwan. Over a period of 10 years, considering direct, indirect and induced effects, this results in a SOB ranging from 121.25 billion US\$ in Taiwan to 2665.63 billion US\$ in China. In absolute terms, China showed a particular increase in the SOB of migraine, where it almost tripled. This is due to the increase in productivity over this period.

In terms of these losses as a percentage of GDP, the direct productivity losses due to migraine ranges from 0.4% in Japan to 0.6% in Taiwan in 2021. When considering the additional indirect and induced losses, this number increases to 1.0% in Japan to 1.7% in Taiwan. Consequently, focusing on the direct effect of migraine on productivity, which is typically done in burden of disease studies (Eltrafi *et al.*, 2023), might underestimate the effect of the disease on the whole economy.

A comparison of the SOB of migraine with the SOB of diabetes and cardiovascular diseases further contextualizes these results. Under the conservative approach of estimating productivity losses due to mortality, it is shown that the productivity losses related to migraine are similar to those of cardiovascular diseases and diabetes.

It should be noted that, in comparison to cardiovascular diseases and diabetes, the SOB of migraine has been declining in rank over time in China and Taiwan when considering both men and women, and shows a consistent slight downward trend in all the included countries. From an epidemiological perspective, this slight downward trend is related to the changing demographics in these countries, where older people become a relative larger part of the population of these countries (Chen *et al.*, 2024). Additionally, over time, the relative importance of the burden of migraine has decreased compared to diabetes and cardiovascular disease. This shift can partly be attributed to an aging and increasingly unhealthy population, which has led to a rise in the number of people affected by cardiovascular disease and diabetes (Liu *et al.*, 2020; Roth *et al.*, 2020). Still, migraine remains an important contributor to the SOB of women over time.

Here, it should be noted that women's productivity is particularly impacted. In two countries, Japan and Taiwan, the total SOB of women—encompassing both paid and unpaid work—are more than twice those of men. These differences become even larger in the context of productivity losses in terms of unpaid work. To illustrate, this difference is twelve-fold in South Korea. This significant disparity can be attributed to the greater disease burden of migraine among women and the higher number of hours women dedicate to unpaid work.

Altogether, these findings illustrate the high SOB of migraine in all the included countries. This burden is particularly concerning, due to the fact that migraine affects some of the most productive members of society. Additionally, the four countries in question are facing the challenges of a rapidly aging population. To illustrate, estimates by the United Nations indicate that in 2000, every individual older than 65 was supported by about 8 (China), 8 (Taiwan), 9 (South Korea), 4 (Japan) individuals aged 20-64 years old (*World Population Prospects - Population Division - United Nations*, no date). By 2030, this is projected to change to about 4, 3, 3, and 2 respectively. Consequently, the productivity losses in terms of paid work in this young population might put increasing pressure on the national budgets of these countries.

Additionally, unpaid work, which is primarily conducted by women, also includes care taking (Gerth *et al.*, 2001). Considering that women are particularly affected by migraine, this could result in problems in caretaking in the future as well, where other paid or unpaid work activities are neglected. Furthermore, this could result in additional pressure on the national budgets, if individuals do not get the care they need through informal unpaid work.

Some limitations of the current approach must be mentioned. The economic and demographic figures reported in this study, including the multipliers for direct, indirect, and induced effects, are based on aggregated available databases. As such, they lack granularity with respect to potential differences in the type of workers that get



certain diseases and their potential effect on different industrial sectors. For example, the average relatively young woman who has migraine likely works in a different type of industry than the average older man who suffers from a cardiovascular disease. Future research could explore how these granular differences influence the direct, indirect, and induced effects of disease on an economy. An additional downside of the use of aggregated data is that mortality and YLD data of China includes Hong Kong and Macao, while economic data solely reports mainland China. The effect is a slight overestimate of the SOB of the included diseases in China. Another limitation is related to the fact that individuals affected by disease also require additional caregiving. The effect of disease on caregiving and its relation to the supply of labor has also not been examined. With respect to GBD data, it is important to note that this database relies on reported data from individual countries. Although the GBD study uses advanced methodologies to take care of any potential inconsistencies, there is still the possibility that there are differences between locally reported data and estimates from IHME. Additionally, potential inconsistencies in how countries gather and report data could affect cross country comparisons of disease burden.

To conclude, migraines significantly affect both paid and unpaid work productivity in China, Japan, South Korea, and Taiwan. This SOB is most prevalent among individuals in their most productive years. Women are disproportionately impacted, with gender disparities in unpaid work responsibilities further amplifying losses in unpaid work productivity. Addressing the burden of migraines could not only boost economic activity but also help reduce strain on government budgets.

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Annex

4.1 Methodology

This section will provide a more detailed overview of the methodology that is used in this report. Table 2 at the end of this annex provides an overview of the indicators that are used, how and where they can be identified, and how they are called throughout this manuscript (also include time use survey info here).

4.1.1 Overview of key assumptions

For the analysis that is reported in this study, various methodological assumptions had to be made due to data availability and to facilitate the conduct of this study. The first key assumption is related to the use of YLD to estimate productivity losses. Here, it should be noted that DALY equals the loss of one year in full health. The loss of one year in full health is translated into a loss of one year of average working capability for both paid and unpaid work activities. With respect to YLDs, this means that any DALYs lost due to YLDs are assumed to result into a loss of one year of average working capability.

The second key assumption is that YLLs and YLDs are having the same effect on productivity. With respect to YLLs, it is possible that particularly in light of the FCA there are differences between countries in the speed to which workers can be replaced. Similarly, also with respect to YLDs, it is possible that there are national differences in how disease affects the productivity of workers, due to difference in presenteeism and absenteeism patterns.

The third key assumption is that the prevalence as reported by the IHME is a good reflection of the national disease prevalence estimates. Of course, on a national level, many methodologies exist to estimate the prevalence of disease. This could mean that there are deviations between national estimates and estimates by the IHME. We opted to use the IHME due to the benefits of using a uniform methodology to estimate prevalence in various countries, which directly results in the possibility to make cross country comparisons of the socioeconomic burden of disease.

4.1.2 Inputs regarding burden of disease

Data from the GBD study was used to evaluate the SOB of migraine, cardiovascular diseases, and diabetes. Specifically, the analysis utilized disease burden data, in terms of mortality and YLD, categorized by 5-year age groups (ranging from 15 to 95+ years), gender (male, female, and combined), and country. This data covered the period from 2012 to 2022.



4.1.3 Economic inputs

The comprehensive assessment of the economic effects of disease in terms of direct and spillover effects is based on Input-Output (IO) modelling (Conway, 2022). The essential underlying principle of IO models is that the economy consists of interconnected economic sectors. This means that an increase in production in one sector leads to an increased demand in (intermediate) inputs, the production of which results in additional productivity in other sectors.

To calculate these effects, we utilized an established algorithm from WifOR, which utilizes WIOD (*World Input-Output Database*, 2016) and EORA (*Eora Global MRIO*, 2024) databases. Essentially, for each country, a specific Leontief inverse of the IO matrix is calculated (Leontief, 1986). This represents how change in a unit of output in one sector results in changes in output of all the other industrial sectors of a country. Through the introduction of quotes of each sector that represent the gross value added and the employment needed for a unit of output in each sector, we estimate the indirect effect of how adjacent sectors affect each other's creation of value and the contribution of employment. Additionally, through incorporating household consumption in the Leontief inverse, we account for how changes in productivity of a sector result in changes in demand by households, which leads to an estimation of the induced effects of changes in the productivity of a country.

The analysis is conducted per country, which means that any international effects (e.g. a reduction of productivity in Japan leading to a reduction in productivity in South Korea) are not accounted for. Industrial sectors are defined according to the NACE Rev.2 classification (Eurostat, 2008).

For each country, the following multipliers from IO analysis are derived and used to calculate direct, indirect, and induced effects.

- Direct multiplier per revenue increase (hereafter DirMult.Rev): this multiplier reflects the increase in GVA by each sector, for every additional 1 million USD in revenue (i.e. gross output, total value of sales, production value).
- Indirect multiplier per revenue increase (hereafter IndirMult.Rev): this multiplier reflects the effect of an increase in 1 million USD sector revenue on GVA.
- Induced multiplier per revenue increase (hereafter InducMult.Rev): this multiplier reflects the effect increased expenditures due to increases in directly or indirectly generated income due to an increase in 1 million USD sector revenue on GVA.
- GVA per economic sector (million USD) (hereafter GVA.PSector): this is an estimation of GVA generated per economic sector, that is based on the IO matrices of a country.
- Employees per economic sector (million of people) (hereafter EMP.PSector): an estimation of the number of employees per economic sector, based on IO matrices of a country.

4.1.4 GVA effects from paid work

Understanding how disease burden impacts individual productivity requires estimating the GVA generated per person. In the case of paid work, this is further narrowed down as the GVA generated by an employed person. The World Bank defines an employed person as “persons of working age who, during a short reference period, were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference



period (i.e., who worked in a job for at least one hour) or not at work due to temporary absence from a job, or to working-time arrangements” (World Bank, 2024a).

In order to study the impact of disease on the GVA of paid work, three different effects are assessed:

- Direct effects: these effects reflect the immediate impact of a decrease in paid work due to disease.
- Indirect effects: these effects reflect the decrease in GVA due to a decrease in intermediate consumption.
- Induced effects: these effects reflect the decrease in GVA due to a decrease in expenditures by households.

The three multipliers introduced in the previous section (DirMult.Rev, InderMult. Rev and InducMult.Rev) are needed to evaluate these three different effects from paid work (direct, indirect and induced effects), as well as the estimation for the GVA per economic sector (GVA.PSector).

Direct effects:

To estimate direct effects, a monetization of the average GVA per employee is calculated. For each country (c) and year (t), this is estimated by dividing the total GVA of a country (GVA.2015Pr) by the number of employed individuals in a population aged 15 years or older (Employees.15m), with the following equation:

$$DirectEffect.PerEmployee_{c,t} = GVA.2015Pr.PerEmployee_{c,t} = \frac{GVA.2015Pr_{c,t}}{Employees.15m_{c,t}}$$

Indirect effects:

To estimate indirect effects, we account for the interconnections between economic sectors. The indirect effect of disease therefore assesses the losses in productivity that are a consequence of a loss of demand for intermediate goods and services. Here, we again estimate indirect effects in terms of GVA per person. To do so, the input IndirMult.Rev (indirect multiplier per revenue increase) is transformed into IndirMult.GVA (indirect multiplier per GVA increase), by making use of the input DirMult.Rev (direct multiplier per revenue increase). For this, the following formula is used for each country (c) and economic sector (s):

$$IndirMult.GVA_{c,s} = \frac{IndirMult.Rev_{c,s} - DirMult.Rev_{c,s}}{DirMult.Rev_{c,s}}$$

To comprehensively capture the indirect multiplicative effects across all sectors, we applied the indirect total economy-wide average multiplier (TAv.MultIndir.GVA) for each country (c). This multiplier is calculated by dividing the total indirect GVA effects across the economy (i.e., the sum of indirect effects by economic sector, or GVA.Psector*IndirMult.GVA) by the total GVA. The latter is obtained from the sum of GVA generated by each economic sector (GVA.Psector), based on IO analysis.

$$TAv.MultIndir.GVA_c = \sum_{s=1}^S (GVA.Psector_{c,s} * IndirMult.GVA_{c,s}) / \sum_{s=1}^S (GVA.PSector_{c,s})$$



Since only cross-sectional data, not time series data, is available for multipliers and GVA per sector, we assume that both the multipliers and the sectoral GVA distribution remain constant over time. As a result, we applied the average indirect GVA multiplier (TAv.MultIndir.GVA) to the direct effects derived from the time series data provided by the World Bank (DirectEffect). The indirect effects were then calculated by multiplying the average indirect GVA multiplier with the direct GVA effects in the economy.

$$IndirectEffect_{c,t} = DirectEffect_{c,t} * TAv.MultIndir.GVA_c$$

Induced effects:

Direct and indirect effects occur across multiple sectors, generating induced effects throughout different parts of the value chain. Therefore, we need to estimate the induced effect multiplier per additional dollar of GVA (InducMult.GVA), rather than per additional dollar of sector revenue increase. This is obtained from dividing the induced effect multiplier per revenue increase (InducMult.Rev) by the direct multiplier per revenue increase (DirMult.Rev):

$$InducMult.GVA_{c,s} = \frac{InducMult.Rev_{c,s}}{DirMult.Rev_{c,s}}$$

To comprehensively capture the multiplicative effects across all sectors, we applied the induced total economy-wide average multiplier (TAv.MultInduc.GVA) for each country (c). As before, this multiplier is calculated by dividing the total induced GVA effects the economy (GVA.Psector*InducMult.GVA) by the total GVA.

$$TAvMultInduc.GVA_c = \frac{\sum_{s=1}^S (GVA.Psector_{c,s} * InducMult.GVA_{c,s})}{\sum_{s=1}^S (GVA.PSector)}$$

As in the case of the indirect effects, we assume that these multipliers and the GVA distribution per sector remain constant over time. As a result, the induced effects are calculated by multiplying the average induced GVA multiplier (TVaMultInduc.GVA) with the direct GVA effects in the economy (DirectEffect):

$$InducedEffect_{c,t} = DirectEffect_{c,t} * TAvMultInduc.GVA_c$$

Total paid work effects:

The average effect of disease on reducing paid work (PaidW.PerEmployee) is then equal to the sum of the three calculated effects (DirectEffect, IndirectEffect and InducedEffect).

$$PaidW.PerEmployee_{c,t} = DirectEffect_{c,t} + IndirectEffect_{c,t} + InducedEffect_{c,t}$$

4.1.5 GVA effects from unpaid work

Given the nature of unpaid work, an indirect estimation of its productivity in monetary terms is necessary. To do so, several issues must be considered. First, it is important to account for the differences in productivity between countries. These differences are the result of different factors, such as the level of investment in the human or physical capital, or institutional and governmental policies (Hall and Jones, 1999). Second, due to the nature of unpaid work (e.g. preparation of meals, household upkeep, care taking of family), it is likely that there is a difference



in the value of the productivity of unpaid work as compared to paid productivity in other sectors. To address this difference, we use data from a sector that is similar to unpaid work. To illustrate this, we assume that the value of household upkeep by an unpaid worker is similar to the productivity of hired household help.

To account for the differences between countries, the general approach is to start our estimation of the value of unpaid work of a certain country by calculating the relationship between time spent on paid and unpaid work for the different countries. Then, we initially assume the same level of productivity in terms of GVA for both paid and unpaid work. After “anchoring” the value of unpaid work to the GVA of paid work of a country, we adjust the value of unpaid work with information about the value of productivity in terms of GVA of a sector that produces similar output as paid work. Following the second revision of the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2), we assume that the sector with output most similar to unpaid work is “Sector T”, which reflect the output of “households as employers; undifferentiated goods- and services-producing activities of households for own use” (Eurostat, 2008). For simplicity, we call this sector Unpaid Substitution Economic Sector (USES) from here onwards.

In more detail, we used a combination of time-use survey data, data from the IO analysis and data from the World Bank. With time-use survey data, we calculate the ratio of time spent on unpaid work per hour to time spent on paid work per individual. For China, Japan, and South Korea paid work hours were calculated by subtracting the number of unpaid work hours from total work hours. For Taiwan data from the Survey on Social Development Trends was used (DGBAS, n.d.b). As already explained in the method section, this data presents time use across different specific categories, such as time used on having meals, commuting, or work. These categories were reclassified to paid and unpaid work according to the International Classification of Activities for Time Use Statistics 2016 (UN Statistics Division, 2017). Consequently, the time spent on work was used as an indicator for paid work, and time spend on housework, taking care of family, educating children, shopping or errands as indicators for time spend on unpaid work. This resulted in the following parameter inputs:

Table 1. Paid and unpaid working hours by country and gender

Country	Gender	Paid work hours	Unpaid work hours	Reference
China	Women	3.94	3.68	UN Statistics Division (2024a)
	Men	5.76	1.42	
Japan	Women	3.07	3.53	UN Statistics Division (2024a)
	Men	5.35	0.90	
South Korea	Women	2.43	3.35	UN Statistics Division (2024a)
	Men	4.13	0.80	
Taiwan	Women	3.68	2.80	DGBAS (n.d.b)
	Men	5.05	0.68	

These inputs were used to calculate gender specific work time ratios, with the following formulas:

$$WorkTimeRatio.Male_{c,t} = UnpaidHours.Male_c / PaidHours.Male_{c,t}$$

$$WorkTimeRatio.Female_{c,t} = UnpaidHours.Female_c / PaidHours.Female_{c,t}$$



Where UnpaidHours.Male is the number of unpaid hours worked by men, UnpaidHours.Female is the number of unpaid hours worked by women, PaidHours.Male is the number of hours spent on paid work by men, and PaidHours.Female is the number of paid hours spent on paid work by women, by country (c) and year (t).

Then, per employee, an estimation is made regarding the value of their unpaid work in terms of GVA. This is done with the following formula:

$$UnpaidWork.PerEmployee_{c,g,t} = (GVA.2015Pr_{c,t} * WorkTimeRatio_{c,g,t}) / Employees.15m_{c,t}$$

With GVA.2015Pr being the GVA of a country in 2015 USD, WorkTimeRatio the ratio calculated in equation 9, and Employees.15m the number of paid workers 15 years and older, by country (c), gender (g), and year (t). This value essentially represents the value of unpaid work activities in terms of the average GVA produced by men and women in a country. However, as mentioned, this value needs further adjustment to more closely resemble the real value of unpaid work. This adjustment is explained in the next steps.

With data from the IO analysis, an estimation is made about the proportion of GVA that is contributed by USES relative to the output of all economic sectors. Assuming that this proportion remains stable over time, the annual GVA figures from the World Bank are multiplied by this proportion, to estimate the yearly contribution of USES to GVA over time. Following this, we calculate the proportion of individuals working in USES relative to all employees in all sectors and use this proportion to calculate the annual number of workers in USES over time. Then, we estimate the productivity per employee working in USES per year (GVA.2015Pr.PerEmployee.USES) by dividing the estimated contribution to GVA per year by the estimated number of employees working in USES. These steps are summarized in the following equation:

$$GVA.2015Pr.PerEmployee.USES_{c,t} = \left(\frac{GVA.PSector.USES_{c,USES}}{\sum_{s=1}^S (GVA.PSector_{c,s})} \right) * GVA.2015Pr_{c,t} / \left(\frac{EMP.PSector.USES_{c,USES}}{\sum_{s=1}^S (EMP.PSector_{c,s})} \right) * Employees.15m_{c,t}$$

Where GVA.PSector.USES corresponds to the GVA in the USES sector, EMP.PSector.USES to the number of people employed in the USES sector by country (c). It should be noted that there are deviations in both the GVA and number of employees between the World Bank and IO analysis, due to differences in the exact way that these numbers are estimated.

With the estimated GVA per person for employees in the USES sector, a ratio is calculated which represents the productive value of an employee working in this sector relative to the productive value of an employee in the general population (GVA.Unpaid.AdjRatio). This ratio is calculated by dividing the per person GVA added of an employee in the USES sector by the general per person GVA of an employed individual, with the following formula:

$$GVA.Unpaid.AdjRatio_{c,t} = GVA.2015PR.PerEmployee.USES_{c,t} / GVA.2015Pr.PerEmployee_{c,t}$$

This ratio is then finally used to adjust the value of unpaid work calculated earlier (UnpaidWork.PerEmployee), using the following formula:

$$UnpaidWork.Adj.PerEmployee_{c,g,t} = UnpaidWork.PerEmployee_{c,g,t} * GVA.Unpaid.AdjRatio_c$$



Here, it should be noted that for the current report, there was a lack of data regarding the USES sector for China, Japan, and South Korea. Therefore, it was not possible to estimate the $GVA.Unpaid.AdjRatio$ for these countries. We therefore used the $GVA.Unpaid.AdjRatio$ from Taiwan as a proxy of the relative value of unpaid work in all the included countries in this analysis.

4.1.6 Health outcome metrics and the SOB of disease

For the SOB of disease analysis, we assume on a general level that individuals contribute to society in terms of paid and unpaid work throughout the year, and that years lost due to morbidity or mortality lead to productivity losses. To calculate these lost years, we use the Disability Adjusted Life Year (DALY) concept by the GBD of disease study (IHME, 2024b). DALYs are calculated on the basis of Years Lived with Disability (YLDs) and Years of Life Lost (YLL). These metrics have been developed to make it possible to compare morbidity and mortality across diseases.

In order to evaluate the impact of disease in terms of YLD and YLL on productivity, we need to establish the maximum age that individual can stay productive. In other words, the maximum productive age needs to be established. For paid work, this is typically the effective retirement age. Although the official retirement ages differ between countries (e.g. men in China can retire at the age of 60, while the retirement age in Japan is 65), it is common that the actual effective retirement age is higher (e.g. 65 for men in China and 68.3 for men in Japan) (OECD, 2023). For unpaid work, we assume that people remain productive until the age of 85. Combined, the value of both paid and unpaid work is comprehensively assessed.

To evaluate the effect of morbidity on productivity, we use YLDs. YLDs represent the burden of disease on those living with a disease. This burden is reflected as the “health” that is lost living with disease. Through the way that this health loss is estimated, this burden reflects years lost. To illustrate, if a disease results in a burden of 0.5, then two years of living with this disease is equal to living 1 year in complete health, or in other words, over a period of 2 years, someone living with a disease with a burden of 0.5 “loses” 1 year of life. In relation to productivity, we assume that these losses reflect lost time in productivity due to absenteeism and presenteeism. To monetize this loss in productivity ($MVal.YLD.UnpaidW.PerEmployee$ and $MVal.YLD.PaidW.PerEmployee$), the country- and year-specific YLD of a disease (YLD) is multiplied with the country- and year average paid and unpaid work productivity ($UnpaidWork.Adj.PerEmployee$ and $PaidW.PerEmployee$).

For unpaid work, the following formula is used:

$$MVal.YLD.UnpaidW.PerEmployee_{c,g,t} = UnpaidWork.Adj.PerEmployee_{c,g,t} * YLD_{c,g,t}$$

Where (c) represents the country, (g) the gender, and (t) represents the year.

For paid work, we use the following formula, which also account for the proportion of individuals who is employed with the variable $EmplToPop.15m.T.Per$:

$$MVal.YLD.PaidW.PerEmployee_{c,g,t} = PaidW.PerEmployee_{c,t} * EmplToPop.15m.T.Per_{c,t} * YLD_{c,g,t}$$

Where again (c) represents country, (g) gender, and (t) represents year.



The total monetary value of the lost productivity due to the morbidity of a disease for a specific country and year (MVal.YLD.PerEmployee) is then calculated by the sum of productivity losses in paid and unpaid work with the following formula, by (t) year, (g) gender, and (c) country:

$$MVal.YLD.PerEmployee_{c,g,t} = MVal.YLD.UnpaidW.PerEmployee_{c,g,t} + MVal.YLD.PaidW.PerEmployee_{c,g,t}$$

To evaluate the effect of mortality on productivity, we calculate an adapted version of YLL. Where in the original GBD study YLL represents the life years lost in relation to life expectancy, we are interested in productive YLL lost, thus related at productive life expectancy. To calculate our adapted YLL, we use mortality estimated from the GBD study by age group, country, and year. To monetize the productivity losses related to YLL lost, we use two approaches: the FCA and the HCA.

For the FCA, we assume that the productivity of an individual can be replaced by another individual. To illustrate, if a company loses an employee through disease, then the company might hire a substitute, or might innovate, or conduct further adaptation to the production process to substitute the loss of an employee. This, of course, takes time. In this report, we therefore assume that the loss in productivity due to mortality is one year, or in other words, we assume that per deceased person, one year of productive work is lost.

Productive years of life lost are therefore the sum of all the deaths by country (c), gender (g), year (t), and age group (a) as follows:

$$YLLFCA_{c,g,t} = \sum_{a=1}^A (Deaths_{c,g,t,a})$$

Where the oldest age group for unpaid work is 80 to 84, the oldest age group for paid work depends on the effective retirement age of different countries. In our analysis, we used a report from the OECD (OECD, 2023), in which the following effective retirement ages are mentioned: 65 for men in China, 60 for women in China, 68.3 for men in Japan, 67 for women in Japan, 67.4 for women in South Korea, 65.4 for men in South Korea. For Taiwan, a report from the Asian Productivity Organization was used (APO, 2011), which reported an effective retirement age of 61.8 for men and 59 for women. The monetized loss of these years is calculated with the following formula for unpaid work:

$$MVal.YLLFCA.UnpaidW.PerEmployee_{c,g,t} = UnpaidWork.Adj.PerEmployee_{c,g,t} * YLLFCA_{c,g,t}$$

Where UnpaidWork.Adj.PerEmployee refers to the earlier estimated monetary value of one year of an individual's unpaid productivity for a specific (c) country, (g) gender, and (t) year. For paid work, the following formula is used:

$$MVal.YLLFCA.PaidW.PerEmployee_{c,g,t} = PaidW.PerEmployee_{c,t} * EmplToPop.15m.T.Per_{c,t} * YLLFCA_{c,g,t}$$

Where PaidW.PerEmployee refers to the earlier estimated monetary value of the individual's productivity of paid work, and EmplToPop.15m.T.Per refers to the proportion of employed people by (c) country, (g) gender, and (t) year. The total loss in productivity due to mortality in terms of FCA is then calculated by summing the loss in productivity of paid and unpaid work with the following formula, by (c) country, (g) gender, and (t) year:



$$\begin{aligned}
& MVal.YLLFCA.PerEmployee_{c,g,t} \\
& = MVal.YLLFCA.UnpaidW.PerEmployee_{c,g,t} + MVal.YLLFCA.PaidW.PerEmployee_{c,g,t}
\end{aligned}$$

For the HCA, it is assumed that an individual's death during her or his productive years results in a loss of productivity that cannot be replaced. Here, it is important to recall that productive years are defined according to effective retirement age for paid work and 84 years for unpaid work. Given that we have mortality data by age groups, we conduct the following steps to calculate the years of productive life that are lost:

- From the GBD study, the smallest range available for age groups are selected, which is mortality by 5-years (e.g. mortality in the age group of 15 to 19 years old, mortality in the age group of 20 to 24 years old etc.).
- On average, we assume that the average age of death within an age group is the midpoint of that age group. To illustrate, in the age group 20 to 24, we assume that the average of death is 22.5.
- To calculate the productive years of life lost for an age group, we then subtract the maximum productive age of paid and unpaid work from the average mentioned in the last step. For example, for the age group of 20 to 24, we subtract as follows: 84-22.5 = 61.5 productive years of unpaid work lost if an individual dies within this age group.
- To calculate the full number of years of life lost due to the number of deaths, we multiply the number of deaths per age group with the age specific value of productive years lost (e.g. number of deaths in age group 20-24 multiplied by 61.5 for unpaid work). For paid and unpaid work, these are referred to as YLLpaid and YLLunpaid.
- To value future productivity losses to the respective year that an individual dies, a discount rate of 3.5% is applied.

These steps above can be summarized by the following formulas:

$$\begin{aligned}
& MVal.YLLHCA.UnpaidW.PerEmployee_{c,g,t} \\
& = \sum_{a=1}^A \left[\sum_{i=1}^{YLLunpaid} \left[Deaths_{a,c,g,t} * UnpaidWork.Adj.PerEmployee_{c,g,t} * \frac{1}{(1 + DiscRate)^i} \right] \right]
\end{aligned}$$

Where a = age group, i= each year of productive life lost (i= 1...YLLunpaid or YLLpaid), c= country, g = gender, t = to the evaluated year, and DiscRate = 3.5%.

The monetary value of SOB of disease due to mortality calculated with the HCA is the sum of paid and unpaid productivity losses, which is calculated with the following formula:

$$\begin{aligned}
& MVal.YLLHCA.PerEmployee_{c,g,t} \\
& = MVal.YLLHCA.UnpaidW.PerEmployee_{c,g,t} + MVal.YLLHCA.PaidW.PerEmployee_{c,g,t}
\end{aligned}$$

It should be noted that there are extensive debates in health economic literature whether the FCA or HCA should be used, see for example Brouwer and Koopmanschap (2005) and Targoutzidis (2018). In this report, we refrain from making a judgement in this debate but do consider the FCA the conservative approach for estimating productivity losses. We therefore mainly report FCA based estimates throughout this study.



The complete SOB of disease, due to both mortality and morbidity, is then the sum of the productivity losses calculated with YLD and productivity losses calculated with life years lost (according to the HCA and the FCA). For this, the following formula is used, by (c) country, (g) gender, and (t) year:

$$MVal.Total.PerEmployee_{c,g,t} = MVal.YLD.Total.PerEmployee_{c,g,t} + MVal.YLL.Total.PerEmployee_{c,g,t}$$

Here, it should be noted that the gender specific estimates for men and women are then summed to calculate the overall effect of disease on productivity losses.

Table 2. Variables and data sources

Name in formulas	Name in data source	Reference
Disease parameters		
YLD*	YLD	IHME (2024b)
Deaths	Mortality	IHME (2024b)
Economic parameters		
GVA.2015Pr	GVA 2015 US\$†	World Bank (2024b) for Japan and South Korea UN Statistics Division (2024b) for China DGBAS (n.d.a) for Taiwan
GVA.CurrPr	GVA current US\$	World Bank (2024b) for Japan and South Korea UN Statistics Division (2024b) for China DGBAS (n.d.a) for Taiwan
GDP.2015Pr	GDP 2015 US\$	World Bank (2024b) for China, Japan and South Korea DGBAS (n.d.a) for Taiwan
GDP.CurrPr	GDP current US\$	World Bank (2024b) for China, Japan and South Korea DGBAS (n.d.a) for Taiwan
Deflating NT\$ 2016 to 2015		DGBAS (n.d.a)
2015 NT\$ US\$ exchange rate		DGBAS (n.d.a)
IndirMult.Rev	Not applicable, not public	WifOR's input/output model
InducMult.Rev	Not applicable, not public	WifOR's input/output model
GVA.PSector.USES	Not applicable, not public	WifOR's input/output model
GVA.PSector	Not applicable, not public	WifOR's input/output model
EMP.PSector.USES	Not applicable, not public	WifOR's input/output model
EMP.PSector	Not applicable, not public	WifOR's input/output model
Effective retirement age	Not applicable. Not from database, but from paper	OECD (2023) for China, Japan and South Korea APO (2011) for Taiwan
Time use		
UnpaidHours.Male	Total time spent on unpaid domestic and care work	UN Statistical Division (2024a) for China, Japan and South Korea DGBAS (n.d.a) for Taiwan
UnpaidHours.Female	Total time spent on unpaid domestic and care work	UN Statistical Division (2024a) for China, Japan and South Korea DGBAS (n.d.a) for Taiwan



Name in formulas	Name in data source	Reference
PaidHours.Male	See explanation in the annex	UN Statistical Division (2024a) for China, Japan and South Korea DGBAS (n.d.a) for Taiwan
PaidHours.Female	See explanation in the annex	UN Statistical Division (2024a) for China, Japan and South Korea DGBAS (n.d.a) for Taiwan
Demographic		
Pop.Fem.Per	Population, female (% of total population)	World Bank (2024b) for China, Japan and South Korea MOI (2018) for Taiwan
Pop.Male.Per	Population, male (% of total population)	World Bank (2024b) for China, Japan and South Korea MOI (2018) for Taiwan
Pop.1564.T	Population ages 15-64, total	World Bank (2024b) for China, Japan and South Korea MOI (2018) for Taiwan
Pop.60m.T	Population ages 65 and above, total	World Bank (2024b) for China, Japan and South Korea MOI (2018) for Taiwan
EmplToPop.15m.T.Per	Employment to population ratio, 15+, total (%) (modeled ILO estimate)	World Bank (2024b) for China, Japan and South Korea MOI (2018) for Taiwan

*YLD: years lived with disability, †GVA: gross value added



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WifOR is an independent economic research institute, founded in 2009 as a spin-off from the Technical University of Darmstadt. As experts in macroeconomic analysis, our research focuses on the areas of labor markets, health, and sustainability. Through our studies, WifOR's mission is to enable data-based solutions to challenges on the labor market, set global standards in sustainability measurement, and illuminate worldwide the value of health investments. WifOR has over 75 employees located in Germany, Greece, Latin America, and the USA.

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