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Global, regional, and national survey on burden and quality of care index (QCI) of nasopharyngeal cancer: A systematic analysis of the Global Burden of disease study 1990–2019

Saba Ilkhani [a,1], Sahar Saeedi Moghaddam [a,b,1], Delaram Sakhaei [c], Mohammad-Mahdi Rashidi [a], Sina Azadnajafabad [a], Mohammadreza Azangou-Khyavy [a,d], Naser Ahmadi [a], Ozra Tabatabaei-Malazy [a,e], Mohammadreza Naderian [a,f], Erfan Ghasemi [a], Parnian Shobeiri [a], Sahar Mohammadi Fateh [a], Farzad Kompani [g], Bagher Larijani [e], Farshad Farzadfar [a,e,*]

[a] Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran
[b] Kiel Institute for the World Economy, Kiel, Germany
[c] School of Medicine, Sari Branch, Islamic Azad University, Sari, Iran
[d] School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[e] Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran
[f] Tehran Heart Center, Cardiovascular Diseases Research Institute, Tehran University of Medical Sciences, Tehran, Iran
[g] Division of Hematology and Oncology, Children's Medical Center, Pediatrics Center of Excellence, Tehran University of Medical Sciences, Tehran, Iran

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ABSTRACT

Background: The epidemiology and inequitable management of nasopharyngeal cancer (NPC) have long been a source of interest due to the malignancy's distinctive geographic distribution.
Objective: This study evaluates NPC burden and it's quality of care by socio-demographic index (SDI) groups and world regions from 1990 to 2019.
Methods: We gathered epidemiologic metrics (incidence, prevalence, mortality, years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life years (DALYs) from Global Burden of Disease (GBD) study data. The quality-of-care index (QCI) was rescaled to 0–100 using principal component analysis (PCA).
Results: Global NPC incidence rose 161.4 % from 1990 to 2019. However, low and low-middle-income countries experienced a decline. While the all-age crude incidence has risen, DALYs and mortality decreased. NPC's QCI in 2019 was 80.3, increased 110.2 % from 1990. Nevertheless, QCI growth rates were not uniform across SDI categories. High-middle SDI nations improved from 41.8 to 94.1, whereas low SDIs improved from 14.8 to 16.9. In 2019, Singapore (100.0) had the highest, while Somalia (13.2) had the lowest QCI. Young people (<40) receive the best care at almost all SDI levels, and the gender gap is shrinking in lower SDI quantiles with time.
Conclusion: The quality of care in all nations and regions has increased over time. However, the disparity between locations is widening. Significantly greater care is offered in nations with high or above-average financial status. Regarding the role of different risk factors on NPC, additional sub-analyses based on different subtypes of NPC in various parts of the world are warranted.

1. Introduction

Nasopharyngeal cancer (NPC), formerly known as lymphoepithelioma, is a cancer of the epithelium which is mainly caused by a complicated interaction of genetic vulnerability and Epstein Barr virus (EBV) infection [1,2]. According to Global Cancer Incidence,

* Corresponding author. Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Second Floor, No.10, JalalAl-e-Ahmad Highway, Iran.
E-mail address: f-farzadfar@tums.ac.ir (F. Farzadfar).
[1] Joint first authors.

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Mortality and Prevalence (GLOBOCAN) 2020, there were over 133,000 newly diagnosed cases of nasopharyngeal cancer, making it the 18th and 22nd most prevalent cancer among men and women, respectively [3]. The burden of NPC is substantial, especially when considering distorted quality-of-life measures and rising expenditures [4]. NPC's management is costly owing to expensive diagnosis modalities and high sensitivity to radiotherapy and chemotherapy [1].

The relationship between nutrients and NPC has been a topic of discussion for many years. A higher intake of an animal-based nutrient was associated with an increased risk of NPC, whereas a higher intake of a plant-based nutrient was associated with a decreased risk of NPC. In addition, preserved food appeared to play a role at younger ages [5]. However, salted fish and other preserved foods were the weakest risk factors for NPC in all periods and may play a more minor role in NPC occurrence than previously believed [6]. A recent study suggests multiple metabolic markers, including Body Mass Index (BMI), hemoglobin, and albumin, as significant pharyngeal cancer predictors [7]. Regarding tobacco use, both active and passive smoking are linked to a slightly higher risk of NPC [8]. Being a smoker or a former smoker can also reduce their chances of survival [9].

World Health Organization (WHO) defines the quality of care (QoC) as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes" [10]. Fortunately, healthcare stakeholders are beginning to grasp about the disparities in care quality in all parts of the system [11]. Some indices have been created to analyze inequities in proper care access, such as the concentration index and horizontal inequity; nevertheless, there is no complete and unbiased measure to compare the quality of care and discriminations [12,13].

This paper uses a comprehensive indicator termed the QCI to compare disparities in NPC care quality internationally, regionally, and nationally using the GBD data from 1990 to 2019.

2. Methods

2.1. Data source

The NPC data were derived from the GBD 2019 study. The methodology and findings of the GBD 2019 study can be found in a previous publication [14]. The present study supplies crude and age-standardized estimates of incidence, prevalence, mortality, years of life lost (YLLs), years lived with disability (YLDs), disability-adjusted life years (DALYs) through global and regional scales including four world regions (Africa, America, Asia, and Europe), six WHO regions(Africa, America, South-East Asia, Europe, Eastern Mediterranean and Western Pacific), and national scales of 204 countries. Furthermore, GBD's most recent Socio-Demographic Index (SDI) estimates were utilized as a summary metric to identify countries' development status. SDI is a cumulative average of the rankings of incomes per capita, average education levels, and fertility rates of all areas in the GBD study nations' development status [15]. Moreover, for analytical purposes, the World Bank income categories which divides countries' economies into four income groups: low, lower-middle, upper-middle, and high income were used. WHO uses statistics on gross national income (GNI) per capita in US dollars, converted into local currency using the World Bank Atlas approach, which smooths out exchange rate volatility.

2.2. QCI

The following are four primary quality-of-care indices that we developed:

1. Prevalence to incidence ratio $= \frac{Prevalence\ rate}{Incidence\ rate}$.
2. Mortality to incidence ratio $= \frac{Mortality\ rate}{Incidence\ rate}$.
3. DALYs to prevalence ratio $= \frac{DALYs\ rate}{Prevalence\ rate}$.
4. YLLs to YLDs ratio $= \frac{YLLs\ rate}{YLDs\ rate}$.

The trend of each index can be easily determined. The first index evaluates the prevalence to incidence ratio, in which higher rates suggest better care and prevention. Mortality to incidence ratio is an epidemiological measure of care quality which its high rate reflects the worse quality of care with the same incidence rate of the illness. The DALYs to prevalence ratio indicates that with higher DALYs there is poorer care quality with the exact prevalence across geographical areas. Higher values of the fourth ratio indicate worse prospects since the low quality of care in a location leads to higher YLLs and fewer YLDs (patients die sooner than their mean life expectancy). This ratio assumes that living with an NPC-related disability is superior to dying in advance. The principal component analysis (PCA) approach was used to sum up these four indices into one secondary unique index. PCA is a multivariate statistical technique that extracts complementary components from a linear combination of different datasets [16]. The first component extracted from PCA was the Quality-of-Care Index, abbreviated as QCI in our study. QCI values were calculated and scaled from zero to 100, with higher scores signifying greater care quality. The protocol of calculating QCI was previously reported [17]. The results of different regions were illustrated on the world map.

2.3. GDR

For calculating the Gender Disparity Ratio (GDR), the QCI values for females were divided by the QCI values for males. GDRs near one, suggest a lesser gender disparity.

$$GDR = \frac{QCI\ Female}{QCI\ Male}$$

2.4. QCI validation

The Healthcare Access and Quality (HAQ) index was developed by the Institute for Health Metrics and Evaluation (IHME) to assess the quality of care and access [18]. Numerous previous publications prove the QCI validity [17,19–33]. We calculated the association between QCI and the HAQ index for NPC to validate the present QCI index. QCI was used as the dependent variable, while inpatient health care utilization, outpatient health care utilization, mortality, and attributed death rates to NPC risk factors were considered independent variables, and countries' effects were assumed to have random effects. In the case of NPC, the Pearson correlation coefficient between estimated values and the HAQ index was 0.5.

2.5. Data analysis

All epidemiological measures used to calculate the QCI were given by their 95 % uncertainty intervals (UIs). This study reported age groups with 5-year intervals (i.e., 5–9, 10–14, 15–19, 20–24, … 75–79, and 80+). R statistical packages v 4.1.3 (http://www.r-project.org/, RRID: SCR 001905) were used to analyze and visualize the results [34].

3. Results

3.1. Overview

From 1990 to 2019, the age-standardized incidence, prevalence, and YLDs rates of NPC increased globally. The age-standardized deaths, YLLs, and DALYs of NPC, on the other hand, declined in a statistically significant trend by 31.3 % (95 % UIs: −38.9 to −22.5), 34.6 % (−42.0 to −25.7), and 32.9 % (−40.6 to −23.8), respectively. All of the burden measures by all-age-number were increased. The worldwide prevalence of NPC almost quadrupled, rising from 243,481 (223,234 to 262,233) in 1990 to 971,936 (845,408 to 1,119,384) in 2019. The number of deaths

Table 1
Global trend of primary indices of nasopharyngeal cancer for all-ages numbers and age-standardized rates, in 1990 and 2019 and percent of changes with QCI.

Year	Incidence		Prevalence		Deaths		YLLs		YLDs		DALYs		QCI
	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	
1990	67518 (61729–72995)	1.5 (1.4–1.7)	243481 (223234–262233)	5.4 (5–5.8)	53459 (48875–57906)	1.3 (1.2–1.4)	1851376 (1688182–2021511)	41 (37.4–44.7)	29326 (21065–38799)	0.7 (0.5–0.9)	1880702 (1715976–2050611)	41.7 (38.1–45.4)	38.2
2019	176502 (156046–199917)	2.1 (1.9–2.4)	971936 (845408–1119384)	11.7 (10.2–13.4)	71610 (65442–77625)	0.9 (0.8–0.9)	2238361 (2045463–2428099)	26.8 (24.5–29.1)	96735 (68515–130872)	1.2 (0.8–1.6)	2335096 (2139753–2536658)	28 (25.7–30.4)	80.3
1990–2019 (%)	161.4 (124.4–204.5)	37.1 (18.2–59.4)	299.2 (237.6–372.5)	115.3 (82.9–153.8)	34 (19.3–51.8)	−31.3 (−38.9 to −22.5)	20.9 (7–37.6)	−34.6 (−42 to −25.7)	229.9 (181.5–291.7)	73.4 (48.5–105.3)	24.2 (9.7–41.1)	−32.9 (−40.6 to −23.8)	110.2

QCI: Quality of care index; UI: Uncertainty interval.

and DALYs increased relatively modestly during the same period (Table 1). As the all-age number of YLDs, incidence, and prevalence of NPC rocketed drastically in world bank-based high-income countries, the number of deaths and DALYs increased slightly during the corresponding period (Table S1). The rate of increase in the prevalence and incidence of NPC was relatively higher in upper-middle-income countries. It is worth noting that the age-standardized rate of NPC prevalence and incidence decreased in low- and low-middle-income nations (Table S1). It was demonstrated that the incidence of NPC rises as a country's Socio-demographic qualities improve (higher SDI regions). However, throughout the years stated, the death number in high SDI nations plummeted, falling from 5552 (5139–5977) in 1990 to 5021 (4908–5122) in 2019 (Table 2).

3.2. Quality of care index (QCI)

Globally the QCI for NPC increased persistently by 110.2 % (38.2–80.3) from 1990 to 2019. At first glance at the geographical distribution of age-standardized QCI for NPC (Fig. 1), it is clear that the rise in quality of care between 1990 and 2019 occurred in most countries. According to the four world regions and the six WHO region categorizations, Europe (86.09) and Western Pacific Regions (90.97) had the highest QCI of NPC in 2019, respectively (Table 3). Singapore (100.0 %), Australia (99.9), and Canada (99.85) were provided the finest quality of care, while Somalia (13.2) and the Central African Republic (13.7) were on the other end of the spectrum (Table S2). The global QCI doubled during the time and reached 80.3 %, this ratio indicates that the care provided to the overall population is equivalent to 80.3 % of the best available health system in action (i.e., Singapore).

The provided line graph represents age-standardized QCI values among four World Bank income levels over 30 years (Fig. 2a). It can be clearly seen that the QoC improved across all income levels. However, the change was most noticeable in upper-middle-income (it increased by 187.6 % in upper-middle-income while the increase rate was around or less than 50 % in other levels) (Table S1).

Similar to World Bank income levels, QCI values in all SDI quintiles increased in 2019 compared to 1990. In 1990, the two extremes of healthcare quality in the case of NPC were high-middle SDI with a QCI of 76.2 and low SDI with a QCI of 14.8. In the middle SDI regions, the QoC showed a dramatic upward trend (216.2 % increase), overtaking that of high SDI in 2019 (Fig. 2b). By 2019, high-middle SDI countries reached the highest healthcare quality with a QCI of 94.1, followed by high SDI counterparts with a QCI of 92.9. In contrast, the low SDI quantile experienced the slightest change across the period, rising only 14.2 % to reach 16.9 % by 2019 (Table 2). When comparing a socio-demographic quantile's top and lowest QCIs, the difference between the highest and the lowest was 61.4 in 1990, but in 2019, this difference increased to 77.2, which means the care quality gap between lower and upper quantiles is broader in 2019 than in 1990 (Table 1).

3.3. Age disparity

As illustrated in Fig. 3, the QCI for NPC was bimodal in most areas, with a peak in the young population, a gradual decline in all groups after 40 years, and a jump in the elderly in higher SDI quantiles. For middle-SDI nations, the pattern is the same, except that care for children and adolescents is considerably better and exceeds global statistics, in contrast to the QCI for individuals over 65, which was lower than the global index. However, the QCI in high and high-middle SDI countries is comparable to and greater than the worldwide index. In these countries, the QCI is constantly high for all ages, apart from declining for the ages of 60 and 64 before rising to the prior level for elderly groups. It is important to note that the QCI for older adults in high-SDI countries is slightly greater than in high-middle SDI countries. Additionally comparable are the QCIs for low- and low-middle SDI nations. The QCI score is higher for low-middle SDI countries, reaching a new peak for those

Table 2
Primary indices of nasopharyngeal cancer for all-ages numbers and age-standardized rates, in 1990 and 2019 and percent of changes - based on SDI regions with QCI.

SDI Quintile	Year	Incidence		Prevalence		Deaths		YLLs		YLDs		DALYs		QCI
		Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	Number (95 % UI)	Rate (95 % UI)	
High SDI	1990	10903 (10624–11237)	1.1 (1.1–1.2)	56632 (54713–58876)	6 (5.8–6.3)	5021 (4908–5122)	0.5 (0.5–0.5)	155272 (152106–158298)	16.4 (16.1–16.7)	5983 (4310–7890)	0.6 (0.5–0.8)	161255 (157625–164721)	17 (16.7–17.4)	76.2
	2019	19265 (17281–21480)	1.3 (1.2–1.4)	115726 (103578–129729)	8 (7.2–9)	5552 (5139–5977)	0.3 (0.3–0.4)	147596 (136621–159957)	10 (9.3–10.9)	11797 (8361–15650)	0.8 (0.6–1)	159393 (146905–173317)	10.8 (10–11.8)	92.9
	1990–2019 (%)	76.7 (58.3–96.3)	12.9 (0.8–25.8)	104.3 (81.7–128.3)	33.3 (18.4–49.3)	10.6 (3.2–19.1)	−34.7 (−39.1 to −29.7)	−4.9 (−11.9 to 3)	−38.9 (−43.4 to −33.7)	97.2 (76.3–121.8)	24.7 (10.7–40.5)	−1.2 (−8.5 to 7)	−36.5 (−41.3 to −31.1)	21.9
High-middle SDI	1990	18963 (16645–21359)	1.7 (1.5–1.9)	70886 (61922–80799)	6.2 (5.4–7.1)	14536 (12863–16381)	1.3 (1.2–1.5)	489332 (430004–556691)	43.1 (37.9–49.1)	8264 (5883–11157)	0.7 (0.5–1)	497596 (437255–564801)	43.9 (38.6–49.8)	41.8
	2019	68086 (56543–81620)	3.6 (3–4.3)	427039 (350319–516811)	22.7 (18.7–27.3)	17221 (14917–19678)	0.9 (0.8–1)	524032 (452991–599822)	27.4 (23.8–31.3)	39866 (27297–55805)	2.1 (1.4–2.9)	563898 (492008–643059)	29.5 (25.8–33.6)	94.1
	1990–2019 (%)	258.7 (188.8–358.5)	111.3 (70.6–168.6)	502.4 (377.2–671.8)	265.1 (191.4–367.1)	18.5 (−0.5 to 41.2)	−34.2 (−44.6 to −21.6)	7.1 (−11.3 to 28.7)	−36.5 (−47.3 to −23.8)	382.4 (280.4–525.9)	185.1 (124.6–268.6)	13.3 (−6.2 to 35.4)	−32.8 (−44.3 to −19.9)	125.1
Middle SDI	1990	24544 (21723–27165)	2 (1.8–2.2)	78584 (69354–86998)	6 (5.3–6.7)	21554 (19334–23733)	1.9 (1.7–2.1)	759966 (683209–840312)	58.5 (52.6–64.6)	9941 (7099–13192)	0.8 (0.6–1.1)	769908 (692954–849323)	59.3 (53.3–65.4)	25.3
	2019	66542 (57391–76914)	2.2 (1.9–2.5)	357865 (305208–418758)	13.2 (11.3–15.4)	28750 (25630–32051)	1.1 (1–1.2)	878644 (784149–980665)	32.7 (29.2–36.4)	35778 (25003–48688)	1.3 (0.9–1.8)	914423 (819013–1020649)	34 (30.5–37.9)	80
	1990–2019 (%)	134.4 (96.8–180.5)	6.9 (−9.9 to 27.3)	355.4 (272.6–454.7)	118.9 (79.5–166.8)	33.4 (14.6–57)	−40.3 (−48.5 to −30)	15.6 (−1 to 35.6)	−44.1 (−52 to −34.3)	259.9 (194.8–341.9)	65.5 (36.1–103.2)	18.8 (2.1–39)	−42.6 (−50.7 to −32.8)	216.2
Low-middle SDI	1990	9719 (8476–11224)	1.3 (1.2–1.6)	27914 (24231–32424)	3.7 (3.2–4.2)	9128 (8021–10478)	1.3 (1.2–1.5)	329731 (288046–382389)	42.3 (37–48.7)	3813 (2650–5190)	0.5 (0.4–0.7)	333544 (291403–386816)	42.8 (37.6–49.4)	16.9
	2019	16663 (15143–18547)	1.1 (1–1.2)	53981 (48835–60086)	3.4 (3.1–3.8)	14509 (13154–16111)	1 (0.9–1.1)	487557 (440204–543797)	31 (28–34.5)	6945 (4947–9222)	0.5 (0.3–0.6)	494502 (446245–550735)	31.4 (28.4–35)	29.4
	1990–2019 (%)	70.7 (46.6–97.9)	−19 (−30 to −6.6)	93.4 (64.7–127.3)	−6.1 (−19.3 to 9.9)	58.9 (37.6–84.5)	−25.3 (−34.9 to −13.6)	47.9 (27.2–71.8)	−26.8 (−36.8 to −15)	82.1 (56–111.4)	−13.6 (−25.3 to 0)	48.3 (27.6–72.2)	−26.7 (−36.6 to −14.9)	74
Low SDI	1990	3366 (2815–4072)	1.2 (1–1.4)	9386 (7841–11407)	3 (2.6–3.7)	3201 (2685–3851)	1.1 (1–1.4)	116445 (96394–142133)	36.8 (30.8–44.4)	1314 (902–1830)	0.5 (0.3–0.6)	117760 (97503–143749)	37.2 (31.2–45)	14.8
	2019	5896 (5203–6592)	0.8 (0.8–0.9)	17126 (15099–19180)	2.5 (2.2–2.8)	5544 (4904–6231)	0.9 (0.8–1)	199420 (175945–224866)	28.6 (25.2–32.2)	2326 (1629–3169)	0.4 (0.3–0.5)	201746 (177985–227158)	29 (25.5–32.6)	16.9
	1990–2019 (%)	59.9 (32.6–92.9)	−26.5 (−38.2 to −12.7)	82.5 (49.8–122.3)	−16.7 (−30.9 to 0.2)	73.2 (43.8–110.7)	−20.1 (−33 to −4.3)	71.3 (40.4–111.9)	−22.2 (−35.7 to −4.8)	76.9 (46.3–113.1)	−18.9 (−32 to −3.4)	71.3 (40.4–111.8)	−22.2 (−35.6 to −4.8)	14.2

QCI: Quality of care index; UI: Uncertainty Interval; SDI: Socio-demographic index.

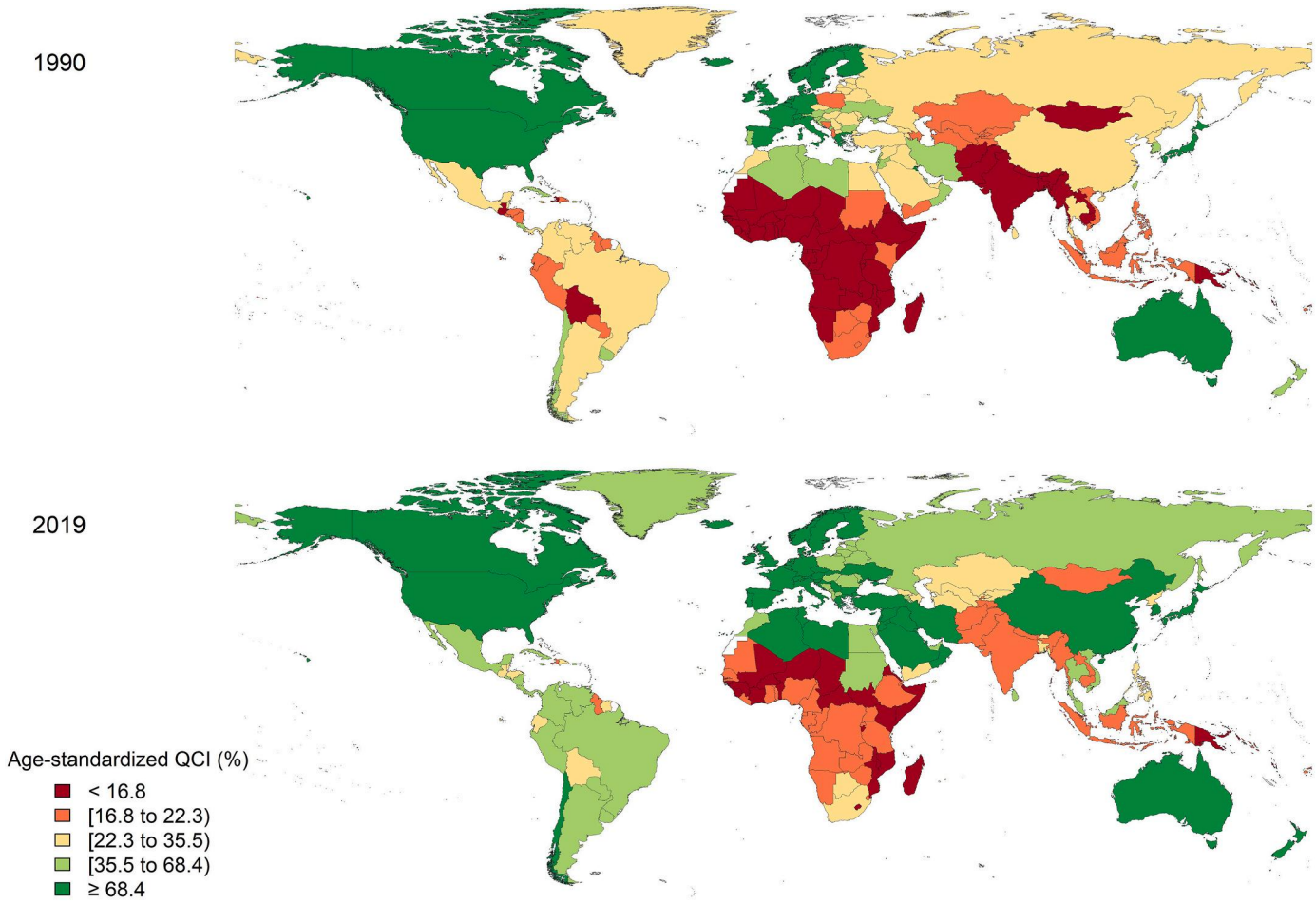

Fig. 1. Geographical distribution of QCI in 204 countries in 1990 (A) and 2019 (B)
QCI: Quality of care index.

Table 3
Age-standardized QCI among world regions and WHO regions.

Location	QCI	
World regions	1990	2019
Africa	22.40	43.26
America	65.29	73.45
Asia	32.00	81.39
Europe	67.56	87.66
WHO regions		
African Region	20.17	35.84
Region of the Americas	65.29	73.45
South-East Asia Region	16.91	23.85
European Region	66.70	86.09
Eastern Mediterranean Region	25.32	52.68
Western Pacific Region	36.63	90.97

QCI: Quality of care index; WHO: World Health Organization.

between the ages of 20 and 24 before declining across all age categories.

3.4. Gender disparity

A glance at Fig. 4a, the age-standardized GDRs categorized by SDI from 1990 to 2019, shows that, despite some minor fluctuations, the global age-standardized GDR remained stable throughout the period. This result can be explained by the fact that low and low-middle SDI countries GDR consistently increased over time, rising from 0.55 to 0.65 to 0.71 and 1.0 in 2019, respectively. On the other hand, in the middle SDI nations, the age-standardized GDR rose to 1.1. For high-middle SDI countries, the pattern is remarkably similar. In the meantime, despite a slight continuous decline in the age-standardized GDR in the high SDI countries, the trend remained remarkably stable.

To be more specific regarding the GDR distribution, it is worth noting that the age-standardized GDR was the highest in both 1990 and 2019 in New Zealand (3.71 and 2.67, respectively). North African countries were the following countries in 2019 (Morocco (2.66) and Egypt (2.41)). Overall, it is evident that the Middle East and North Africa (MENA) countries had the most outstanding levels of age-standardized GDR in 2019. Countries such as the United States, Monaco, Japan, Germany, and Norway provided the most equivalent care for males and females, with their age-standardized GDRs lying around 1. On the other side of the spectrum, Kenya holed the record for the least amount of GDR (0.46), meaning the QCI for males is nearly twice as much as that of females (Table S3).

In addition, Fig. 4b demonstrates the GDR of different countries categorized at global and by SDI in different age groups. Based on the data, it could be concluded that globally, the GDR is highest in 10–14 years old among all age groups. In contrast, the lowest GDR was in 20–24 years old and 75–79 years old. In all age categories, the GDR in high SDI and high-middle SDI is similar and very close to one. The GDR in low-middle and low SDI countries varies significantly by age category, with the highest rate among 5–9 years old (≈1.5 and ≈ 1.3, respectively). However, it declined dramatically in 20–24 years old to a new

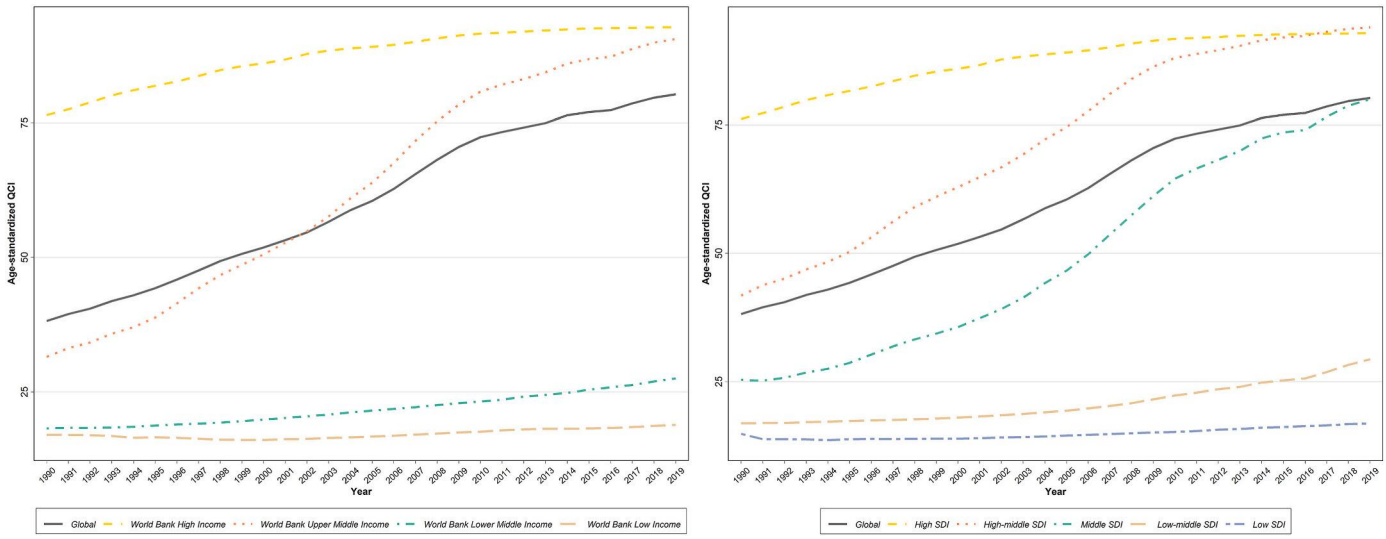

Fig. 2. Time trend of QCI pattern by World Bank income levels (a) and SDI regions (b) from 1990 to 2019
QCI: Quality of care index; SDI: Socio-demographic index.

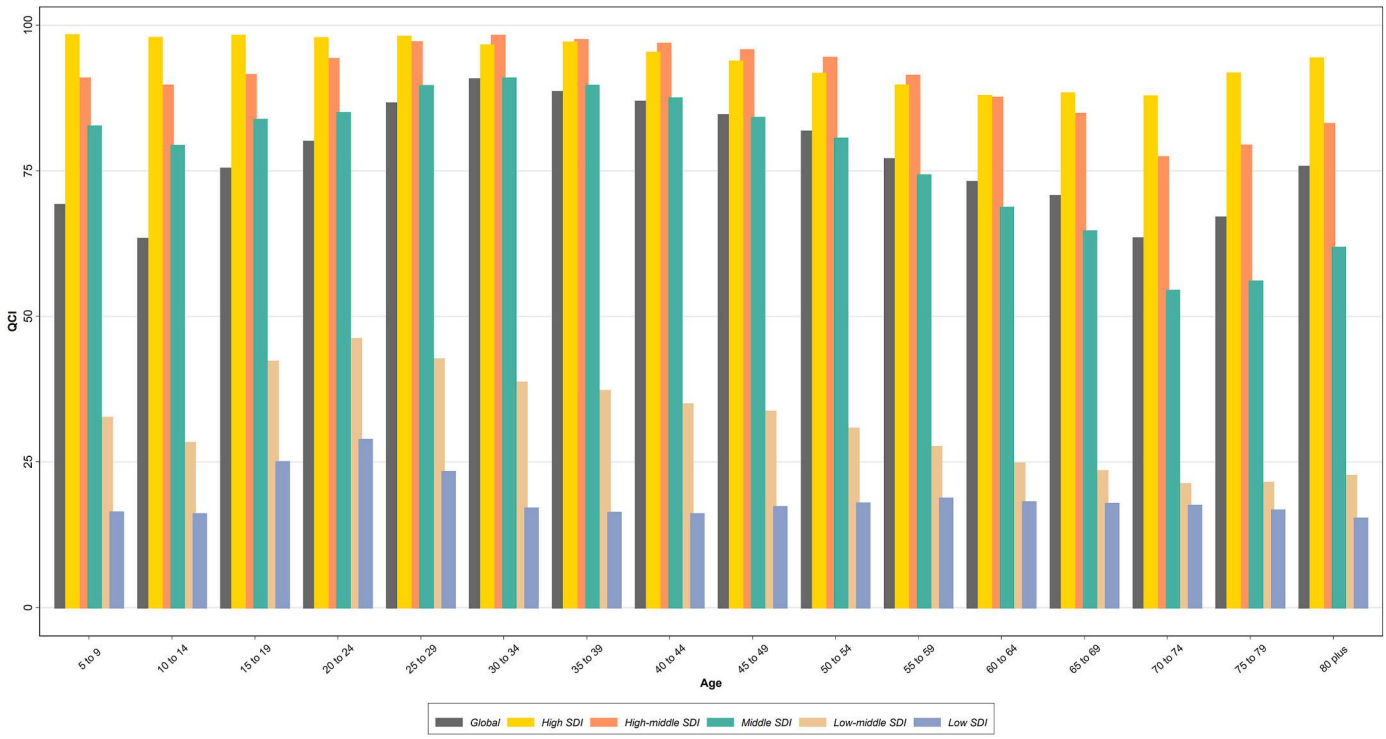

Fig. 3. Age trend of QCI by global and SDI regions in 2019
SDI: Socio-demographic index.

low (≈0.8 and 0.1 respectively). Nevertheless the GDR rose in the 30–34 age group before declining in other age categories.

4. Discussion

Overall, NPC's age-standardized incidence soared from 1990 to 2019. Low-income and low-middle-income countries, as defined by the World Bank income classification, faced a decline. Also, the QCI of NPC increased persistently during the corresponding period. Moreover, the age-standardized GDRs classified by SDI demonstrates that despite a few small changes, the age-standardized GDR remained consistent throughout time. The crude counts of incidence, prevalence, mortality, DALYs, YLLs, and YLDs rose in all regions over time. Nonetheless, some age-standardized disease burden markers, including DALYs, mortality, and YLLs, showed a decreasing pattern.

Initially, for better tracking of how QCI is spreading around the world, WHO regions were investigated. We determined that the Western Pacific and the European Regions had the highest QCI for NPC in 2019,

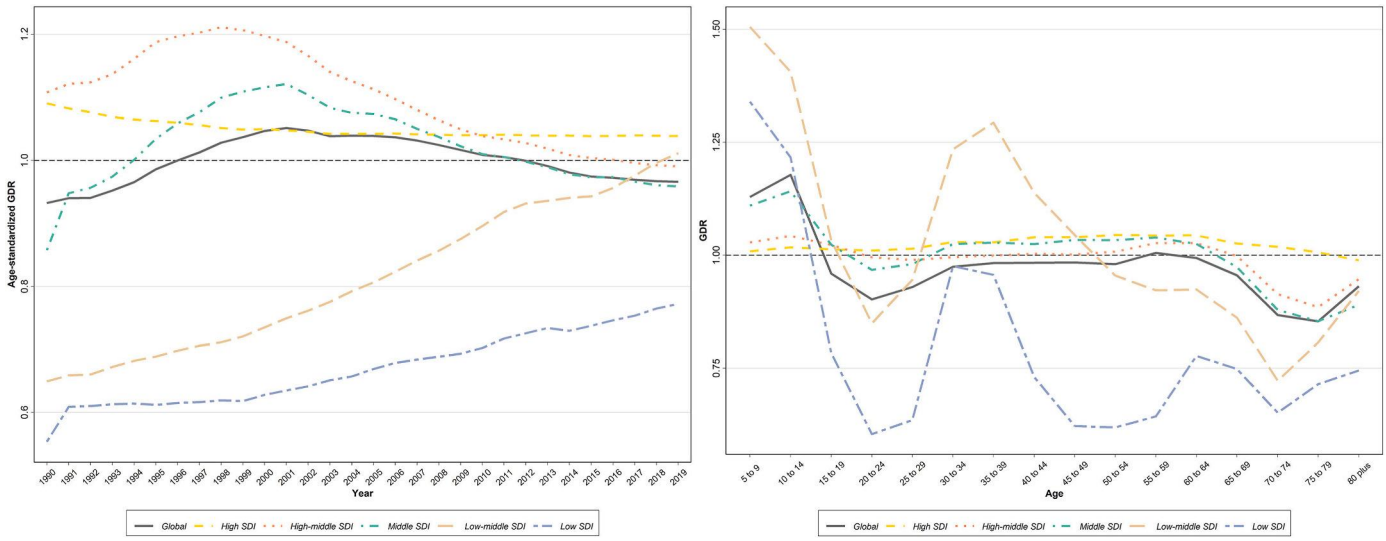

Fig. 4. Time trend of GDR pattern by global and SDI regions from 1990 to 2019 (a) and age pattern of GDR by SDI regions in 2019 (b)
GDR: Gender disparity ratio; SDI: Socio-demographic index.

whereas South-East Asia and African Regions had the lowest QCI. Among Western Pacific Region countries, Singapore and Australia had the highest QCI within 204 countries evaluated worldwide, followed by Canada and Kuwait. Turning to SDI classifications, the trend of QCIs was increasing at various speeds across all quintiles. Despite the general upward attitude, the level of care offered to different SDI locations was not fairly distributed. The care quality gap between lower and upper quantiles is much broader in 2019 than in 1990. Unfortunately, the gap is getting wider for many diseases, such as liver cancer and hematologic malignancies, as access, surveillance, and care are getting better for those with higher Socioeconomic Status (SES) than for those with lower SES [35,36].

The explanation of differences in care quality between nations can be categorized on various levels. First, NPC's particular pathology and risk factors might be one of the sources of QoC heterogeneity among nations. NPC is associated with well-known risk factors, including genetic susceptibility, EBV infection, dietary and lifestyle factors, and smoking [37,38]. In non-endemic areas, the role of tobacco and smoking is more prominent, and dietary factors may also influence NPC survival. In contrast to preserved foods, diet high in fruits and vegetables and Mediterranean diet has been favorably related to NPC risk [39,40]. In endemic areas, EBV infection is arguably the most common cause of NPC among potential risk factors. The non-keratinizing subtype of this malignancy accounts for the majority of cases (>95 %) in endemic areas such as South-Eastern Asia, particularly in Southern China, and some areas in the Middle East, and it is primarily linked to EBV infection [38,41–43]. A survey outlined that in 130000 new cases of NPC diagnosed in 2018, 110000 cases are attributable to EBV infection [44].

Risk factor adjustment may be one of the strongest explanations for the 22 % increase in Singapore's QCI over time, propelling the country to the top of the globe regarding NPC patients' quality of care. According to a survey conducted in Singapore, smoking and consumption of salted vegetables are significant risk factors for NPC, supporting the hypothesis that efficient preventative protocols are one of the primary explanations for their top-tier patient care system [45].

The present study found that China's quality of care index increased from 31.63 to 93.48 over three decades. This represents the greatest delta of progress over time across all nations (61.8 %). A variety of actions can explain this outcome. First, the Chinese focus on the EBV virus by identifying circulating cell-free EBV DNA as a gold standard biomarker for staging, prognosis, and potentially early NPC screening [46–48]. Second, most Chinese centers have established multidisciplinary teams and hold meetings with representatives from all medical and allied health specialties to provide accurate tumor staging and treatment regimens customized to the needs of individual patients [49]. The combined incidence of EBV-related NPC has risen from 1990 to 2017. This surge is noticeable among men. However, females experienced a slight fall (277,000 in 1990 to 274,000 in 2017) [43]. In non-endemic regions, such as the United States and Western Europe, the subtype of keratinizing squamous carcinoma (NPC-type 1) is coupled with cigarette and alcohol use and is less associated with EBV. This type's morphologically resembles other head and neck squamous cell carcinomas [50]. The United States has grown slower than China, climbing from 75.18 to 85.56 in the last 30 years. Despite a general decline in NPC incidence, the Epstein-Barr virus-related, differentiated NPC subtype is increasing across all sexes and races in the United States with clear disparities in incidence and survival among African-Americans [51].

Aside from risk factors, diagnosis and management of the disease can be other explanatory levels of difference in QCI among nations. A long-term cohort study in Indonesia found that age, education level, stage, and first treatment modality were all independent predictors of overall survival [52]. Combining imaging modality-derived parameters with EBV-DNA testing can significantly assist physicians in diagnosis and risk assessment of patients [38,53,54]. Survival and early diagnosis of NPC have a significant impact on the quality of care; a four-year analysis of care performance in one of the largest health centers in Malaysia revealed that the overall survival at 5 years was 100 percent for patients with Stage I disease, 91 percent for Stage II disease, 72 percent for Stage III disease, and 44 percent for Stage IV disease [55]. For non-metastatic NPC, radiotherapy is the mainstay treatment modality, followed by chemotherapy and immunotherapy as complementary therapies [38]. Ultimately, these findings suggest that diagnosing and treating NPC is challenging and extortionate. The finding that higher income countries have higher QCI is consistent with earlier studies that found that a unit increase in radiotherapy equipment per million population is associated with a 3.4 % absolute improvement in the relative survival of NPC [56]. According to a recent survey, every $1000 increase in Gross Domestic Product (GDP) per capita is linked with a 50 % increase in megavoltage units per 1000 cancer cases needing radiotherapy [57]. Accordingly, the QCI for SDIs higher than the middle quintile was 80 % or more in 2019. The highest index was attributed to the high-middle SDI regions with a

QCI of 94.1 %.

From the perspective of age, after 30 years of age, the incidence of NPC rises significantly, peaks between 50 and 59 years old, and then begins to drop after 60 years old. As a result, adults aged 30–59 years old are good candidates for screening in high-incidence areas [58]. Considering NPC cases, the young population in all regions had higher QCIs. However, in high SDI districts, the care offered to patients aged over 80 is approximately comparable to that provided to young cases; this suggests that in high-SDI countries, more attention may have been paid to older NPC patients in terms of early detection and treatment. The best quality of care provided in low and low-middle districts belongs to people aged 15 to 29, whereas this peak occurs in older people aged 25 to 39 in the middle and high-middle regions. Care in high SDI regions is homogeneous from 5 to 40 years. Young patients with NPC typically present at an advanced stage, but their overall prognosis is better than the elderly [59].

From the perspective of gender, in crude Kaplan-Meier analysis of Wang-Zhong Li et al., females with NPC had better Cancer Specific Survival (CSS) rate than males (5-year CSS: 88.5 % vs 81.9 %; 10-year CSS: 78.4 % vs 70.3 %; $P < 0.001$). In a multivariate Cox regression model, after adjusting for demographic, clinical, and treatment factors, female patients still demonstrated longer survival than male counterparts (Hazard Ratio: 0.73, 95 % CI: 0.65–0.83; $P < 0.001$). This study suggests that estrogen may offer protection against NPC [60]. As survival is a part of calculating QCI, the fact that women are more likely to survive due to estrogen or genes can show that the adjusted gender disparity in care quality is worse than it appears.

4.1. Strengths and limitations

This study examines the quality of NPC care at the global, regional, and national levels, as well as other epidemiological characteristics and the disease burden by age and gender and its changes over 30 years. Moreover, it addresses QCI and GDR which are valuable metrics for comparing disease management across countries and empowering policymakers by highlighting differences across countries and regions. Furthermore, The QCI index's validity has been discussed in earlier research [31,61].

There were some limitations to this investigation. Because we used GBD primary data, all the limitations of the GBD study would apply to our analysis. The reliability of the analysis depends on the accuracy and normalization of the data in the GBD database. When dealing with heterogeneous data from several databases, there are bound to be undetected possible bias elements in the GBD database. Because of the immaturity of the disease monitoring and death reporting systems in some impoverished areas, collected data may fail to reflect the NPC burden properly. There is insufficient data in this investigation to assess disease trends by histological subtypes. Previous research has indicated that in regions where NPC is frequent, the undifferentiated form accounts for most cases and is invariably linked to EBV infection. In contrast, differentiated subtypes are more common in non-epidemic locations [4]. While the current study's findings revealed some disparities in the early detection and quality of care of NPC in some regions, other factors such as race, tumor characteristics, and genetic factors may contribute. It is not included these factors or racial and ethnic data in GBD data. As a result, the findings should be interpreted with caution.

5. Conclusion

From evaluating the GBD of the NPC, it can be concluded that despite rising incidence, the QCI is significantly improved from 1990 to 2019. Moreover, the QCI of low and low-middle SDI remains less than 30 % of the best available care (Singapore). In contrast, the average QCI of countries in the middle or higher SDI regions is at least 80 %. The quality of care provided to females in lower SDI areas has lately improved, and the gender disparity ratio is approaching equality over time.

Author contributions

SI, SSM, and FF conceptualized and designed the study. SI, SSM, NA, and EG analysed the data. SI and DS drafted the manuscript. MMR, SA, MA-K, OT-M, MN, PS and SMF revising the manuscript critically for important intellectual content. FK, BL, and FF approved the version of the manuscript to be published.

Ethical statement

No individual data was reported in this paper and the information is based on an aggregated pre-existing online data (available on http://ghdx.healthdata.org/gbd-results-tool). No ethical committee approval was sought for this survey.

Data availability statement

The study protocol and data used in this work are available both from [https://www.protocols.io/view/quality-of-care-index-qci-bprjmm4n] and Global Burden of Disease Results Tool [http://ghdx.healthdata.org/gbd-results-tool]. The authors confirm they had no special access or privileges to the data than other researchers would not have.

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Declaration of competing interest

The authors declare no competing interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.oor.2024.100198.

Abbreviation list

DALYs	Disability-adjusted life years
EBV	Epstein-Barr virus
GBD	Global Burden of Disease
GLOBOCAN	Global Cancer Incidence, Mortality and Prevalence
NPC	Nasopharyngeal cancer
PCA	Principal component analysis
QoC	Quality of care
QCI	Quality of care index
SDI	Socio-demographic index
WHO	World Health Organization
YLDs	Years lived with disability
YLLs	Years of life lost

References

[1] Chua ML, Wee JT, Hui EP, Chan AT. Nasopharyngeal carcinoma. Lancet 2016;387(10022):1012–24.
[2] Tsao SW, Yip YL, Tsang CM, Pang PS, Lau VMY, Zhang G, et al. Etiological factors of nasopharyngeal carcinoma. Oral Oncol 2014;50(5):330–8.

[3] Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA A Cancer J Clin 2021;71(3):209–49.
[4] Yu H, Yin X, Mao Y, Chen M, Tang Q, Yan S. The global burden of nasopharyngeal carcinoma from 2009 to 2019: an observational study based on the Global Burden of Disease Study 2019. Eur Arch Oto-Rhino-Laryngol 2022;279(3):1519–33.
[5] Huang T, Ploner A, Chang ET, Liu Q, Cai Y, Zhang Z, et al. Dietary patterns and risk of nasopharyngeal carcinoma: a population-based case-control study in southern China. Am J Clin Nutr 2021;114(2):462–71.
[6] Barrett D, Ploner A, Chang ET, Liu Z, Zhang CX, Liu Q, et al. Past and recent salted fish and preserved food intakes are weakly associated with nasopharyngeal carcinoma risk in adults in southern China. J Nutr 2019;149(9):1596–605.
[7] Wu CY, Lin YH, Lo WC, Cheng PC, Hsu WL, Chen YC, et al. Nutritional status at diagnosis is prognostic for pharyngeal cancer patients: a retrospective study. Eur Arch Oto-Rhino-Laryngol 2022;279(7):3671–8.
[8] Chang ET, Liu Z, Hildesheim A, Liu Q, Cai Y, Zhang Z, et al. Active and passive smoking and risk of nasopharyngeal carcinoma: a population-based case-control study in southern China. Am J Epidemiol 2017;185(12):1272–80.
[9] Sun XS, Xie SY, Luo DH, Liu LT, Guo SS, Liu SL, et al. Impact of smoking on survival in nasopharyngeal carcinoma: a cohort study with 23,325 patients diagnosed from 1990 to 2016. Radiother Oncol 2021;162:7–17.
[10] World, Health, Organization. Quality of care. 2020. https://www.who.int/health-topics/quality-of-care#tab=tab_1.
[11] Tyssen R, Palmer KS, Solberg IB, Voltmer E, Frank E. Physicians' perceptions of quality of care, professional autonomy, and job satisfaction in Canada, Norway, and the United States. BMC Health Serv Res 2013;13(1):1–10.
[12] Wagstaff A, Van Doorslaer E, Paci P. On the measurement of horizontal inequity in the delivery of health care. J Health Econ 1991;10(2):169–205.
[13] Koolman X, Van Doorslaer E. On the interpretation of a concentration index of inequality. Health Econ 2004;13(7):649–56.
[14] Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet 2020;396(10258):1204–22.
[15] Global Burden of Disease Collaborative Network. Global burden of disease study 2019 (GBD 2019) socio-demographic index (SDI) 1950–2019. Seattle, United States of America: Institute for Health Metrics and Evaluation (IHME); 2020.
[16] Rencher AC. A review of "methods of multivariate analysis, second edition". IIE Trans 2005;37(11):1083–5.
[17] Mohammadi EGE, Moghaddam SS, Yoosefi M, Ali Ghanbari, Ahmadi N, et al. Quality of care index (QCI). 2020 [Updated 21 Nov 2020 Available from: https://www.proto.cols.io/view/quali.ty-of-care-index-qci-bprjmm4n.
[18] Measuring performance on the healthcare access and quality index for 195 countries and territories and selected subnational locations: a systematic analysis from the global burden of disease study 2016. Lancet 2018;391(10136):2236–71.
[19] Abbasi-Kangevari M, Ahmadi N, Fattahi N, Rezaei N, Malekpour MR, Ghamari SH, et al. Quality of care of peptic ulcer disease worldwide: a systematic analysis for the global burden of disease study 1990-2019. PLoS One 2022;17(8):e0271284.
[20] Azadnajafabad S, Saeedi Moghaddam S, Keykhaei M, Shobeiri P, Rezaei N, Ghasemi E, et al. Expansion of the quality of care index on breast cancer and its risk factors using the Global Burden of Disease Study. Cancer Medicine; 2019. p. 2022. n/a(n/a).
[21] Mohammadi E, Ghasemi E, Azadnajafabad S, Rezaei N, Saeedi Moghaddam S, Ebrahimi Meimand S, et al. A global, regional, and national survey on burden and Quality of Care Index (QCI) of brain and other central nervous system cancers; global burden of disease systematic analysis 1990-2017. PLoS One 2021;16(2):e0247120.
[22] Hanifiha M, Ghanbari A, Keykhaei M, Saeedi Moghaddam S, Rezaei N, Pasha Zanous M, et al. Global, regional, and national burden and quality of care index in children and adolescents: a systematic analysis for the global burden of disease study 1990-2017. PLoS One 2022;17(4):e0267596.
[23] Khanali J, Malekpour MR, Azangou-Khyavy M, Saeedi Moghaddam S, Rezaei N, Kolahi AA, et al. Global, regional, and national quality of care of gallbladder and biliary tract cancer: a systematic analysis for the global burden of disease study 1990-2017. Int J Equity Health 2021;20(1):259.
[24] Keykhaei M, Masinaei M, Mohammadi E, Azadnajafabad S, Rezaei N, Saeedi Moghaddam S, et al. A global, regional, and national survey on burden and Quality of Care Index (QCI) of hematologic malignancies; global burden of disease systematic analysis 1990-2017. Exp Hematol Oncol 2021;10(1):11.
[25] Aminorroaya A, Yoosefi M, Rezaei N, Shabani M, Mohammadi E, Fattahi N, et al. Global, regional, and national quality of care of ischaemic heart disease from 1990 to 2017: a systematic analysis for the Global Burden of Disease Study 2017. Eur J Prev Cardiol 2022;29(2):371–9.
[26] Sofi-Mahmudi A, Masinaei M, Shamsoddin E, Tovani-Palone MR, Heydari MH, Shoaee S, et al. Global, regional, and national burden and quality of care index (QCI) of lip and oral cavity cancer: a systematic analysis of the Global Burden of Disease Study 1990-2017. BMC Oral Health 2021;21(1):558.
[27] Nejad M, Ahmadi N, Mohammadi E, Shabani M, Sherafati A, Aryannejad A, et al. Global and regional burden and quality of care of non-rheumatic valvular heart diseases: a systematic analysis of Global Burden of Disease 1990-2017. Int J Qual Health Care 2022;34(2).
[28] Aryannejad A, Tabary M, Ebrahimi N, Mohammadi E, Fattahi N, Roshani S, et al. Global, regional, and national survey on the burden and quality of care of pancreatic cancer: a systematic analysis for the Global Burden of Disease study 1990-2017. Pancreatology 2021;21(8):1443–50.
[29] Azadnajafabad S, Saeedi Moghaddam S, Mohammadi E, Rezaei N, Ghasemi E, Fattahi N, et al. Global, regional, and national burden and quality of care index (QCI) of thyroid cancer: a systematic analysis of the Global Burden of Disease Study 1990-2017. Cancer Med 2021;10(7):2496–508.
[30] Azadnajafabad S, Saeedi Moghaddam S, Keykhaei M, Shobeiri P, Rezaei N, Ghasemi E, et al. Expansion of the quality of care index on breast cancer and its risk factors using the Global Burden of Disease Study 2019. Cancer Med; 2022.
[31] Nejadghaderi SA, Roshani S, Mohammadi E, Yoosefi M, Rezaei N, Esfahani Z, et al. The global, regional, and national burden and quality of care index (QCI) of colorectal cancer; a global burden of disease systematic analysis 1990-2019. PLoS One 2022;17(4):e0263403.
[32] Momtazmanesh S, Saeedi Moghaddam S, Malakan Rad E, Azadnajafabad S, Ebrahimi N, Mohammadi E, et al. Global, regional, and national burden and quality of care index of endocarditis: the global burden of disease study 1990–2019. European Journal of Preventive Cardiology 2021;29(8):1287–97.
[33] Ghamari SH, Yoosefi M, Abbasi-Kangevari M, Malekpour MR, Saeedi Moghaddam S, Shahin S, et al. Trends in global, regional, and national burden and quality of care index for liver cancer by cause from global burden of disease 1990-2019. Hepatol Commun 2022;6(7):1764–75.
[34] Updated TRPfSCTRF. http://www.r-project.org/; November 1, 2020.
[35] Ghamari SH, Yoosefi M, Abbasi-Kangevari M, Malekpour MR, Saeedi Moghaddam S, Shahin S, et al. Trends in global, regional, and national burden and quality of care index for liver cancer by cause from global burden of disease 1990-2019. Hepatol Commun; 2022.
[36] Keykhaei M, Masinaei M, Mohammadi E, Azadnajafabad S, Rezaei N, Saeedi Moghaddam S, et al. A global, regional, and national survey on burden and Quality of Care Index (QCI) of hematologic malignancies; global burden of disease systematic analysis 1990–2017. Exp Hematol Oncol 2021;10(1):11.
[37] Wu L, Li C, Pan L. Nasopharyngeal carcinoma: a review of current updates. Exp Ther Med 2018;15(4):3687–92.
[38] Chen Y-P, Chan ATC, Le Q-T, Blanchard P, Sun Y, Ma J. Nasopharyngeal carcinoma. Lancet 2019;394(10192):64–80.
[39] Carioli G, Negri E, Kawakita D, Garavello W, La Vecchia C, Malvezzi M. Global trends in nasopharyngeal cancer mortality since 1970 and predictions for 2020: focus on low-risk areas. Int J Cancer 2017;140(10):2256–64.
[40] Salvatore Benito A, Valero Zanuy M, Alarza Cano M, Ruiz Alonso A, Alda Bravo I, Rogero Blanco E, et al. Adherence to Mediterranean diet: a comparison of patients with head and neck cancer and healthy population. Endocrinol Diabetes Nutr (Engl Ed). 2019;66(7):417–24.
[41] Young LS, Dawson CW. Epstein-Barr virus and nasopharyngeal carcinoma. Chin J Cancer 2014;33(12):581–90.
[42] Wong Y, Meehan MT, Burrows SR, Doolan DL, Miles JJ. Estimating the global burden of Epstein–Barr virus-related cancers. J Cancer Res Clin Oncol 2022;148(1):31–46.
[43] Argirion I, Zarins KR, Ruterbusch JJ, Vatanasapt P, Sriplung H, Seymour EK, et al. Increasing incidence of Epstein-Barr virus–related nasopharyngeal carcinoma in the United States. Cancer 2020;126(1):121–30.
[44] de Martel C, Georges D, Bray F, Ferlay J, Clifford GM. Global burden of cancer attributable to infections in 2018: a worldwide incidence analysis. Lancet Global Health 2020;8(2):e180–90.
[45] Yong SK, Ha TC, Yeo MC, Gaborieau V, McKay JD, Wee J. Associations of lifestyle and diet with the risk of nasopharyngeal carcinoma in Singapore: a case-control study. Chin J Cancer 2017;36(1):3.
[46] Lam WKJ, Chan KCA, Lo YMD. Plasma Epstein-Barr virus DNA as an archetypal circulating tumour DNA marker. J Pathol 2019;247(5):641–9.
[47] Young LS. A novel Epstein-Barr virus subtype associated with nasopharyngeal carcinoma found in South China. Cancer Commun 2020;40(1):60–2.
[48] Chan KCA, Woo JKS, King A, Zee BCY, Lam WKJ, Chan SL, et al. Analysis of plasma epstein–barr virus DNA to screen for nasopharyngeal cancer. N Engl J Med 2017;377(6):513–22.
[49] Lang J, Hu C, Lu T, Pan J, Lin T. Chinese expert consensus on diagnosis and treatment of nasopharyngeal carcinoma: evidence from current practice and future perspectives. Cancer Manag Res 2019;11:6365–76.
[50] Carioli G, Negri E, Kawakita D, Garavello W, La Vecchia C, Malvezzi M. Global trends in nasopharyngeal cancer mortality since 1970 and predictions for 2020: focus on low-risk areas. Int J Cancer 2017;140(10):2256–64.
[51] Argirion I, Zarins KR, Ruterbusch JJ, Vatanasapt P, Sriplung H, Seymour EK, et al. Increasing incidence of Epstein-Barr virus-related nasopharyngeal carcinoma in the United States. Cancer 2020;126(1):121–30.
[52] Hutajulu SH, Howdon D, Taroeno-Hariadi KW, Hardianti MS, Purwanto I, Indrasari SR, et al. Survival outcome and prognostic factors of patients with nasopharyngeal cancer in Yogyakarta, Indonesia: a hospital-based retrospective study. PLoS One 2021;16(2):e0246638.
[53] Chan SC, Yeh CH, Yen TC, Ng SH, Chang JT, Lin CY, et al. Clinical utility of simultaneous whole-body (18)F-FDG PET/MRI as a single-step imaging modality in the staging of primary nasopharyngeal carcinoma. Eur J Nucl Med Mol Imag 2018;45(8):1297–308.
[54] Chen YH, Chang KP, Chu SC, Yen TC, Wang LY, Chang JT, et al. Value of early evaluation of treatment response using (18)F-FDG PET/CT parameters and the

Epstein-Barr virus DNA load for prediction of outcome in patients with primary nasopharyngeal carcinoma. Eur J Nucl Med Mol Imag 2019;46(3):650–60.
[55] Abdullah MM, Foo YC, Yap BK, Lee CML, Hoo LP, Lim TO. Retrospective analysis of cancer care performance and survival outcome for nasopharyngeal carcinoma at a leading cancer treatment centre in Malaysia 2008-2012. Asian Pac J Cancer Prev APJCP 2019;20(6):1701–8.
[56] Lam KO, Lee AW, Choi CW, Sze HC, Zietman AL, Hopkins KI, et al. Global pattern of nasopharyngeal cancer: correlation of outcome with access to radiation therapy. Int J Radiat Oncol Biol Phys 2016;94(5):1106–12.
[57] Elmore SNC, Polo A, Bourque JM, Pynda Y, van der Merwe D, Grover S, et al. Radiotherapy resources in Africa: an international atomic energy agency update and analysis of projected needs. Lancet Oncol 2021;22(9):e391–9.
[58] Zong YS, Zhang RF, He SY, Qiu H. Histopathologic types and incidence of malignant nasopharyngeal tumors in Zhongshan County. Chin Med J (Engl). 1983; 96(7):511–6.
[59] Zhu Y, Song X, Li R, Quan H, Yan L. Assessment of nasopharyngeal cancer in young patients aged $\leq$ 30 years. Front Oncol 2019;9.
[60] Li WZ, Lv SH, Liu GY, Liang H, Xia WX, Xiang YQ. Age-dependent changes of gender disparities in nasopharyngeal carcinoma survival. Biol Sex Differ 2021;12 (1):18.
[61] Momtazmanesh S, Saeedi Moghaddam S, Malakan Rad E, Azadnajafabad S, Ebrahimi N, Mohammadi E, et al. Global, regional, and national burden and quality of care index of endocarditis: the global burden of disease study 1990-2019. Eur J Prev Cardiol 2022;29(8):1287–97.