Appendix

The parameters employed in our simulation model are detailed in the following tables. These parameters were used in the initial steady state of our model, which represents a dynamic equilibrium that is numerically sensitive to the model's parameters. This study systematically assessed policies related to the implications of health system (HS) planning at the national level.

Appendix 1: Demographic Parameters in Health System Modeling

Model parameters	Parameters Abbreviation	Unit	Computational formula	Initial parameter value in 2021	Source
Population	Population	Person	Birth-Death	84873300	Iran Statistics Center (1)
Birth	Birth	Person	Birth Rate*Population	-	-
Death	Death	Person	Death Rate*Population	-	-
Birth Rate	Birth Rate	Person	-	1116211/84873300	Iran Statistics Center (1)
Death Rate	Death Rate	Person	-	544515/84873300	Iran Statistics Center (1)

Appendix 2: Population Health Parameters in Health System Modeling

Model parameters	Abbreviation of parameters	Unit	Calculation formula	The initial value of the parameter in 2021	Resource
Population at risk	Risk Pop	Person	Population*" R.Risk"	-	-
Population that is not at risk	Population not at risk	Person	Population*(1-"R.Risk")	-	-
Healthy populations that are at risk	Health.Risk	Person	Risk POP-(Outpatient+ Inpatient)	-	-
Healthy populations that are not at risk	Health.Pop	Person	Population not at risk-(Inpatient1+ Outpatient1)	-	-
Exposure to risk factors	R.Risk	Percent	Biological risk factors+Efficiency and effectiveness of Health System+Lifestyle+Natural and environmental hazards+Risky behaviors	0.35	. GBD 2019 Iran Collaborators (2)
Risks related to lifestyle	Lifestyle	Percent	Cultural+Economic+Social Factors	0.24	The study of Changizi et al. in 2022 (3)
Lifestyle risks according to cultural factors	Cultural	Percent	-	0.02016	According to the referenced study, cultural factors account for 24% of lifestyle-related factors. To calculate the coefficient corresponding to the influence of cultural factors on risk factors, the percentage of risk factors should be multiplied by both the percentage of lifestyle factors and the percentage of cultural factors. The calculation is as follows: 0.35×0.24×0.24=0.02016 This is in accordance with the findings of Alborzi et al.'s 2022 study (4).
Lifestyle risks in line with	Economic	Percent	100-(25+35)	0.02688	According to the 2023 study by Tajbakhsh and Ahmadi (5), economic factors account for

economic factors					32% of lifestyle-related factors. To calculate the coefficient corresponding to the influence of economic factors on risk factors, the percentage of risk factors should be multiplied by both the percentage of lifestyle factors and the percentage of economic factors. The calculation is as follows: 0.35×0.24×0.32=0.02688
Lifestyle risks according to social factors	Social factors	Percent	-	0.03696	According to the 2023 study by Tajbakhsh and Ahmadi (5), and the 2022 study by Nouraei Motlagh et al. (6), social factors account for 44% of lifestyle-related factors. To calculate the coefficient corresponding to the influence of social factors on risk factors, the percentage of risk factors should be multiplied by both the percentage of lifestyle factors and the percentage of social factors. The calculation is as follows: 0.35×0.24×0.44=0.03696
Risks related to natural and environmental factors	Natural and environmental hazards	Percent	-	0.0385	According to the WHO report (7), 11% of risk factors are related to environmental and natural factors. To calculate the coefficient corresponding to the influence of environmental and natural factors on risk factors, the percentage of risk factors should be multiplied by the percentage of environmental and natural factors. The calculation is as follows: 0.11*0.35=0.0385
Risk factors related to the functional inefficiency of the health system	Health system inefficiency	Percent	-	0.035	According to the study conducted by Safavi et al. in 2021 (8), it was found that 10% of the risk factors are attributable to the inefficiency of the HS. Consequently, it is necessary to multiply 0.10 by the 0.35 risk factors in order to derive the corresponding coefficient.
Risky behaviors	Risky behaviors	Percent	Addiction+Depression+Nutrition+Physical Activity+Sexual Behaviors+	0.28	1. The study of Sedighi arfaee and colleagues in 2022 (9) 2. Ebrahimi et al.'s study in 2022 (10)

			Violence		
Risky behaviors related to nutrition	Nutrition	Percent	-	0.0196	According to the study conducted by Azadnajafabad et al. in 2021 (11), it was determined that 20% of high-risk behaviors are associated with nutrition. Therefore, to calculate the proportion of this behavior in relation to risk factors, it is necessary to multiply the percentage of risk factors (0.35) by the percentage of high-risk behaviors (0.28) and the percentage of behavior related to eating habits and nutrition (0.20) to derive the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.28×0.20=0.0196
Risky behaviors related to physical activity	Physical Activity	Percent	-	0.0098	According to the study conducted by Azadnajafabad et al. in 2021 (11), it was determined that 10% of high-risk behaviors are associated with physical activity. Therefore, to calculate the proportion of this behavior in relation to risk factors, it is necessary to multiply the percentage of risk factors (0.35) by the percentage of high-risk behaviors (0.28) and the percentage of behavior related to the amount of physical activity (0.10) to derive the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.28×0.10=0.0098
Risky behaviors related to addiction	Addiction	Percent	-	0.0196	According to the Atlas of Risk Factors of Non-Communicable Diseases in Iran in 2021 (12), it was determined that 20% of high-risk behaviors are associated with drug addiction and abuse. Therefore, to calculate the proportion of this behavior in relation to risk factors, it is necessary to multiply the percentage of risk factors (0.35) by the percentage of high-risk behaviors (0.28) and the percentage of addiction (0.20) to derive the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.28×0.20=0.0196
Risky	Depression	Percent	-	0.0245	According to the Atlas of Risk

behaviors related to depression					Factors for Non-Communicable Diseases in Iran in 2021 (12), it is estimated that 25% of high-risk behaviors are associated with the prevalence of depression in society. Consequently, to determine the proportion of these behaviors in relation to risk factors, the percentage of risk factors should be multiplied by the percentage of high-risk behaviors and the percentage of depression to yield the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.28×0.25=0.0245
Risky behaviors related to violence	Violence	Percent	-	0.0098	According to the Atlas of Risk Factors for Non-Communicable Diseases in Iran in 2021 (12), it is estimated that 10% of high-risk behaviors are associated with violence. Consequently, to determine the proportion of these behaviors in relation to risk factors, the percentage of risk factors should be multiplied by the percentage of high-risk behaviors and the percentage of violence to yield the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.28×0.1=0.0098
Risky behaviors related to sexual behaviors	Sexual Behaviors	Percent	-	0.0147	According to the Atlas of Risk Factors for Non-Communicable Diseases in Iran in 2021 (12), it is estimated that 15% of high-risk behaviors are associated with high-risk sexual behaviors. Consequently, to determine the proportion of these behaviors in relation to risk factors, the percentage of risk factors should be multiplied by the percentage of high-risk behaviors and the percentage of high-risk sexual behaviors to yield the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.28×0.15=0.0147
Biological risk factors	Biological risk factors	Percent	Blood pressure+Blood sugar+Cholestrol+Obesity	0.27	The study of Farmanfarma et al. in 2021 (13)
Biological	Blood	Percent	-	0.02835	According to the study by

risk factors related to blood pressure	pressure				Azadnajafabad et al. in 2021 (11), it is estimated that 30% of biological risk factors are associated with high blood pressure. Consequently, to determine the proportion of this factor in relation to risk factors, the percentage of risk factors should be multiplied by the percentage of biological risk factors and the percentage of high blood pressure to yield the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.27×0.3=0.02835
Biological risk factors related to blood sugar	Blood sugar	Percent	-	0.014175	According to the Atlas of Risk Factors for Non-Communicable Diseases in Iran in 2021 (12), it is estimated that 15% of biological risk factors are associated with high blood sugar. Consequently, to determine the proportion of this factor in relation to risk factors, the percentage of risk factors should be multiplied by the percentage of biological risk factors and the percentage of high blood sugar incidence to yield the corresponding coefficient. Thus, the calculation is as follows: 0.35×0.27×0.15=0.014175
Biological risk factors related to cholesterol	Cholesterol	Percent	-	0.033075	According to the Atlas of Risk Factors for Non-Communicable Diseases in Iran (2021) (12), high cholesterol accounts for 35% of biological risk factors. To calculate the proportion of this factor among all risk factors, the percentage of risk factors, the percentage of biological risk factors, and the incidence rate of high blood cholesterol must be multiplied together to yield the corresponding coefficient. The calculation is as follows: 0.35×0.27×0.35=0.033075
Biological risk factors related to obesity	Obesity	Percent	-	0.0189	As highlighted in the study by Azadnajafabad et al. (2021) (11), obesity accounts for 20% of the biological risk factors. To determine the proportion of this factor among all risk factors, the corresponding coefficient is calculated by multiplying the percentages of risk factors and biological risk factors by the

					incidence rate of obesity. The calculation is as follows: 0.35×0.27×0.2=0.0189

Appendix 3: Service Delivery Parameters in Health System Modeling

Model parameters	Abbreviation of parameters	Unit	Calculation formula	The initial value of the parameter in 2021	Resource
Outpatients in a high-risk population	Outpatient	Person	"O.Patient"-"D.Patient"	20000000	1. Population covered by insurance (health insurance (14) and social security organizations (15))/total number of outpatient visits 2. The resulting coefficient* the total population of Iran = the number of people with outpatient visits
Inpatients in a high-risk population	Inpatient	Person	Hosp-"D.Hos"	5856500	1. Population covered by insurance ((health insurance (14) and social security organizations (15))/total number of inpatient visits 2. The resulting coefficient* the total population of Iran = the number of people with inpatient visits
Admission rate of outpatients in high-risk population	O.Patient	Person	"Health.Risk"*"Sick.Rate"	-	-
Outpatients mortality rate in high-risk populations	D.Patient	Person	"D.O.Patient"*Outpatient	-	-
Outpatient admission percentage in high-risk population	Sick.Rate	Percent	-	0.33	Approximately one third of the at-risk population is referred to and accepted by the outpatient department. This proportion is calculated by dividing the number of outpatients by the total population.
Outpatient mortality percentage in high-risk population	D.O.Patient	Percent	-	0.05	Based on the scholarly articles and the consensus of the experts/focus group team, the mortality rate among outpatients is estimated to be 0.05.
Hospitalization rate in high-risk population	Hosp	Person	"Health.Risk"*"Hos.R"	-	-
Hospital mortality rate in high-risk population	D.Hos	Person	"D.Hos.Rate"*Inpatient	-	-

The percentage of hospitalization in high-risk population	Hos.R	Percent	-	0.1	This is calculated by dividing the number of individuals hospitalized per year by the total population.
Hospital mortality rate in high-risk population	D.Hos.Rate	Percent	-	0.07	In accordance with scholarly articles and the consensus reached by the expert/focus group team, a mortality rate of 0.07 is attributed to patients in hospital care.
Outpatients in a safe population	Outpatient1	Person	"O.Patient1" - "D.Patient1"	5000000	Outpatient referrals within the healthy population encompass instances such as the referral of expectant mothers for prenatal examinations, annual health assessments, cases pertinent to geriatric care, and other factors yet to be identified. These are estimated to constitute approximately 5 million individuals in comparison to the total healthy population. This estimation is derived from scholarly articles and expert consensus.
Inpatients in a safe population	Inpatient1	Person	Hosp1- "D.Hos1"	1033500	In the healthy population, hospitalization referrals encompass instances such as the admission of expectant mothers for childbirth, cases associated with geriatric care, and so forth. These are estimated to represent approximately one million individuals in relation to the total healthy population. This estimation is substantiated by scholarly articles and expert consensus.
The rate of admission of outpatients in healthy and risk-free population	O.Patient1	Person	"Health.Pop" *"Po.P.R"	-	-
Mortality rate of outpatients in healthy and risk-free population	D.Patient1	Person	"D.O.Patient "*Outpatient 1	-	-
Admission percentage of outpatients in healthy and risk-free	Po.P.R	Percent	-	0.06	Based on scholarly articles and expert consensus, it is estimated that approximately 6% of the healthy population have been referred and subsequently

population					accepted for outpatient care.
Mortality percentage of outpatients in healthy and risk-free population	D.O.Patient	Percent	-	0.05	In accordance with scholarly articles and the consensus reached by the expert/focus group team, a mortality rate of 0.05 is assigned to outpatients.
The admission rate of hospitalized patients in healthy and risk-free population	Hosp1	Person	"Health.Pop" *"Po.Ho.R"	-	-
The mortality rate of hospitalized patients in healthy and risk-free population	D.Hos1	Person	"D.Hos.Rate "*Inpatient1	-	-
The percentage of hospitalization in healthy and risk-free population	Po.Ho.R	Percent	-	0.01	Based on scholarly articles and the views of experts, approximately one percent of the healthy population is admitted for treatment and hospitalization.
Mortality percentage of hospitalized patients in a healthy and risk-free population	D.Hos.Rate	Percent	-	0.07	In accordance with scholarly articles and the consensus reached by the expert/focus group team, the mortality rate among hospitalized patients is estimated to be 0.07.

Appendix 4: Parameters for the Growth and Development of Infrastructure (Beds and Medical Equipment) in Health System Modeling

Model parameters	Abbreviation of parameters	Unit	Calculation formula	The initial value of the parameter in 2021	Resource
Number of entrance beds	Bed.R	Digit	("Bed.Dev.Rate"*Population)	-	-
The rate of growth and development of the bed	Bed.Dev.Rate	Digit	-	0.052	1. According to the 2016 study conducted by Haghdoost et al., the estimated number of hospital beds in 2025 was 194,471. However, the actual number of available beds in the same year was reported to be 117,580 (16). The difference between these two values, which amounts to 76,891, provides an estimate of the development of beds over the next decade. By dividing this value by 10, the annual development of beds can be calculated, yielding a figure of approximately 7689 beds per year. Further, by dividing this annual value by the number of active beds in the year 2021 (141,607), the rate of growth and development of the bed can be determined, resulting in a rate of approximately 0.054. 2. According to a report published in an Iranian newspaper, the development of beds in 2021 was reported to be 7,391 beds (17). Dividing this value by the number of active beds in the same year (141,607) results in a rate of approximately 0.052. Please note that the calculations are as follows: 1. The difference between the estimated and actual number of beds in 2016: 194471−117580=76891 The annual development of beds: 76891/10=7689 The rate of growth and development of the bed (based on the annual development): 7689/141607≈0.054 2. The rate of growth and development of the bed (based on the development of beds in 2021): 7391/141607≈0.052

Stock of hospital beds	Beds	Digit	"Bed.R"-Worn out	141607	Statistical database of the country in 2021 (18)
The number of worn beds	Worn out	Digit	Beds*"W.O. Rate"	-	-
The rate of worn beds	W.O.Rate	Digit	-	0.0052	in Production Medicine (19), the useful lifespan of a hospital bed ranges from 10 to 20 years. Consequently, the depreciation rate of the bed can be calculated by multiplying the annual growth rate of hospital beds by 0.1.
Number of active beds	Active beds	Digit	Bed occupancy rate*Beds	-	-
Bed occupancy rate	Bed occupancy rate	Percent	-	0.9	Statistical database of the country in 2021 (18) active beds/approved beds
Bed impatient Daily in annual	Bed impatient Daily in annual	Digit	Active beds*365	-	-
Per capita hospital beds to population	Bed.per.pop	Digit	(Beds/Population)*1000	-	-
The number of medical equipment inputs	M.E.R	Digit	("M.E.R.rate "*Population)	-	-
The rate of growth and development of medical equipment	M.E.R.rate	Digit	-	0.0741	In calculating the annual growth rate of medical equipment, Aghajani et al.'s study (20) was employed to assess the number of medical equipment units for each year between 2016 and 2025. The annual growth rate was then derived by dividing the cumulative increase over the ten-year span. The calculations are as follows: (2194-1316)/1316=0.667 0.667/10=0.0741
Number of worn out medical equipment	Worn out E	Digit	Medical Equipment*" W.O.E.Rate"	-	-
The rate of worn medical equipment	W.O.E.Rate	Digit	-	0.00741	The annual growth rate of medical equipment is determined according to the study by Aghajani et al. (2016) (20). The depreciation time of medical equipment, on the other hand, is provided in the report by the Vice-Chancellor of Support and

					Resource Management of Academic Jihad (21). As per the aforementioned report, the depreciation time for capital medical equipment is considered to be 10 years. Consequently, the wear rate of the equipment can be obtained by multiplying the annual growth rate by 0.1. This calculation provides a comprehensive understanding of the wear rate of the equipment over the specified period.
Stock of medical Equipment	Medical Equipment	Digit	"M.E.R"- Worn out E	1803	According to the study by Aghajani et al. (2016) (20), the annual growth rate of medical equipment was initially calculated. Subsequently, to estimate the quantity of medical equipment for the year 2021, the annual growth rate was multiplied by 5, considering the number of medical equipment available in 2016. This product was then multiplied by the number of available equipment and added to the existing stock. As a result, the estimated number of medical equipment for the year 2021 was obtained. The calculations are as follows: 0.0741×5=0.3705 0.3705×1316=487 487+1316=1803 This approach provides a comprehensive estimation of the number of medical equipment for the year 2021.
Active medical equipment	Active M.E	Digit	"M.E.occupancy rate"*Medical Equipment	-	-
Medical equipment occupancy rate	M.E.occupancy rate	Percent	-	0.4	Iran Analytical News Agency (22)
Per capita medical equipment to population	M.per.pop	Digit	(Medical Equipment/Population)*1000000	-	-
Number of linear accelerators	Linear accelerator	Digit	0.0987*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 244-97/97=1.52 1.52/9=0.168 0.168*5=0.84

					0.84*97=81 81+97=178 178/1803=0.097
Number of PT scans	PT-scan	Digit	0.0055*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 16-3/3=4.3 4.3/9=0.47 0.47*5=2.35 2.35*3=7 7+3=10 10/1803=0.005
Number of CT scans	CT-Scan	Digit	0.389*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 831-546/546=0.52 0.52/9=0.057 0.057*5=0.285 0.285*546=155 155+546=701 701/1803
The number of MRA devices	MRI	Digit	0.185*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 381-276/276=0.38 0.38/10=0.042 0.042*5=0.21 0.21*276=57 57+276=333 333/1803=0.185
Number of peripheral angiography devices	Peripheral angio	Digit	0.029*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 79-21/21=2.76 2.76/10=0.306 0.306*5=1.53 1.53*21=32 32+21=53 53/1803=0.029
Number of angiography devices	Angiography	Digit	0.14*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 311-181=0.72 0.72/9=0.08 0.072*5=0.4 0.4*181=72 72+181=253 253/1803=0.14
Number of gamma cameras	Gamma camera	Digit	0.111*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 226-172/172=0.31 0.31/9=0.034 0.034*5=0.17 0.17*172=29

					29+172=201 201/1803=0.113
Number of CT- Angio devices	CT- Angio	Digit	0.037*Medical Equipment	-	Estimation of variable value based on Aghajani et al.'s study (2016) (20) 106-20/20=4.3 4.3/9=0.47 0.47*5=2.35 2.35*20=47 47+20=67 67/1803=0.037
Cost per hospital bed	Cost per bed	Rials	-	30000000000	According to the report from the Vice-Chancellor of Management and Resources Development of the Ministry of Health (23), an expenditure of 30 billion Rials is incurred for the construction of each bed.
Hospital beds cost	Beds cost	Rials	"Bed.R"*Cost per bed	-	-
The cost of any medical equipment	Cost per medical equipment	Rials	-	The cost incurred for repair and maintenance is 8,488,271,078 Rials. The price associated with each piece of medical equipment is 282,942,369,273 Rials.	Initially, the actual price and value of each piece of capital medical equipment were determined. Subsequently, the sum of these prices was regarded as the total cost of the medical equipment. By dividing this total cost by the total number of equipment available in 2021, the price of each device was calculated. In addition to the purchase price of each device, the cost of its repair and maintenance must also be taken into account. According to the cited reference, based on a working time of 10 years, 3% of the final Riyal value of each device is considered as the maximum limit for repairs. Once this limit reaches 30% after 10 years, the device may be declared as ready for scrapping (24). Therefore, 3% of the actual value of the device has been added to the purchase price to account for its maintenance cost.
Medical equipment cost	Medical equipment cost	Rials	Cost per medical equipment*"M.E.R"	-	-
Investing in the health system infrastructure	Infrastructure investing	Rials	Beds cost+Medical equipment cost+Inintial infrastucture	-	-

			cost		
The initial cost of health system infrastructure	Initial infrastructure cost	Rials	-	-	National Health Accounts of 2019 (25) The estimation of the variable value in 2021 was based on the study conducted by Jahanmehr et al. in 2022 (26).

-Appendix 5: Parameters for the Growth and Development of Infrastructure (Manpower) in Health System Modeling

Model parameters	Abbreviation of parameters	Unit	Calculation formula	The initial value of the parameter in 2021	Resource
Community demand regarding admission in medical and other medical fields	Demand	Person	Population*"Rate.Demand"	-	-
Society's demand rate regarding admission in medical and other medical fields	Rate.Demand	Percent	-	0.0065	The number of national entrance exam candidates in 2021, as well as the number of candidates/applicants in experimental science fields, were obtained from Hiva's academic consulting report (27). The number of candidates/applicants in experimental science fields (554,860 individuals) to the total population (84,873,300) was also calculated.
Admission to the medical field (medical student)	Medical.St	Person	Demand*"Med.St.Rate"	-	-
Admission rate of medical students	Med.St.Rate	Percent	-	0.012	Contemporary Strategy Report on the acceptance capacity in the medical field for the Year 2021 (28) Hiva's Academic Consultation Report on the number of national entrance exam candidates for the year 2021 and the number of candidates/applicants in experimental science fields (27) Acceptance capacity in the general medicine field (6858) compared to the number of candidates/applicants in experimental science fields (554860 individuals)
Admission to other medical students	Other.St	Person	Demand*"Other.St.Rate"	-	-
Admission rate of other medical	Other.St.Rate	Percent	-	0.085	Faros Taha's Report on the acceptance capacity for medical sciences courses in the year 2021

students					(54278 individuals)" (29) Contemporary Strategy Report on the acceptance capacity in the medical field for the year 2021 (6858 individuals) (28) 47420=54278-6858 Acceptance capacity in other medical sciences fields (47420), calculated as total capacity (54278) minus the capacity in the medical field (6858) Comparison of the acceptance capacity in other medical sciences fields (47420) with the number of candidates/applicants in experimental sciences fields (554860 individuals)
Stock of other medical students	Other.Med.St	Person	"Other.St"-"Out.Other"	180620	Number of medical sciences students in 2021: 249131 individuals (30) Given the number of general medical students in 2021 (68511 Individuals), the number of students in other fields of medical sciences for the same year can be calculated by subtracting the number of general medical students from the total number of medical sciences students.
Withdrawal of students of other medical sciences	Out.Other	Person	"Other.Med.St"*"Out.Other.Rate"	-	-
The withdrawal rate of students of other medical sciences	Out.Other.Rate	Percent	-	0.002	Based on the Focus Group Discussion (FGD)
Stock of general medical students	G.P.St	Person	"Medical.St"-"G.P.Enter.Heath.Sys"-"Out.G.P"-"Special.St"	68511	Number of medical sciences students in the year 2021: 249131 Individuals (30) Number of medical sciences students in the year 2019: 200000 individuals (31) Number of general medical students in the year 2019: 55000 individuals (31) Based on the ratios of the above three items, the number of general

					medical students in the year 2021 was calculated to be 68511 individuals.
Withdrawal of general medical students	Out.G.P	Person	"G.P.St"*"Out.G.P.Rate"	-	-
General medical students withdrawal rate	Out.G.P.Rate	Percent	-	0.008	Based on the Focus Group Discussion (FGD)
General physician graduates who enter the health system	G.P.Enter.Heath.Sys	Person	("G.P.St"*"G.P.Enter.Heath.Sys.Rate")-"Out.G.P"	-	-
The rate of entry of graduated general practitioners into the health system	G.P.Enter.Heath.Sys.Rate	Percent	-	0.038	Firstly, the number of general practitioners was calculated and determined over a ten-year period (from 2013 to 2023) based on the Statistics System of the Medical System Organization (32). The number of general practitioners for each year from 2013 to 2023 is as follows: 96822, 94850, 90880, 87005, 83012, 79641, 76589, 73865, 71329, 68736, 66391. Finally, the average annual growth rate over the last ten years was calculated as follows: (0.021+0.044+0.045+0.048+0.042+0.04+0.037+0.036+0.038+0.035)/10
Admission of general physician students in specialized fields	Special.St	Person	"G.P.St"*"Spe.St.Rate"	-	-
Admission rate of general physician students in specialized fields	Spe.St.Rate	Percent	-	0.047	According to a medical education news site, the capacity for student acceptance into assistantships in the year 2021 was 4254 individuals. Given this value, and considering the number of practicing general practitioners in the same year (90832 individuals) as reported by the Medical System Organization's statistical system (32), along with the number of general medicine students (68511 individuals), a calculation was performed. The result of this

					calculation provides the number of students enrolled in assistantship programs from the pool of general medicine students. The calculation is as follows: X=4254*68511/90832 Furthermore, the ratio of a specific number (3208) to the total number of general medicine students is calculated as: 3208/68511=0.047
Stock of specialist medical students	Specialist Students	Person	"Special.St"-"Out.Specialist"-"Spe.Enter.Health Sys"	19930	The number of general medical students in 2019 was 55,000 (31). The number of medical students in specialized assistantships was 16,000 (31). The number of general medical students in 2021 was 68,511. The number of students in assistantships in 2021 was calculated to be 19,930 based on the ratios of these three values.
Withdrawal of medical students from specialized fields	Out.Specialist	Person	"Out.Spe.Rate"*Specialist Students	-	-
The withdrawal rate of medical students from specialized fields	Out.Spe.Rate	Percent	-	0.008	Based on the Focus Group Discussion (FGD)
Specialists who enter the health system	Spe.Enter.Hea lth Sys	Person	("Spe.Enter. Heath Sys.Rate"*Specialist Students)-"Out.Specialist"	-	-
The entry rate of specialists into the health system	Spe.Enter.Hea th Sys.Rate	Percent	-	0.038	Firstly, the number of specialists, sub-specialty, and fellowship doctors was calculated for a ten-year period, from 2013 to 2023, based on the statistics system of the Medical System Organization (32). The numbers for each year are as follows: 2023: 60,459 2022: 59,228

					2021: 56,748 2020: 54,329 2019: 51,835 2018: 49,730 2017: 47,825 2016: 46,124 2015: 44,540 2014: 42,921 2013: 41,457 Finally, the annual growth rate was obtained, and the average growth rate over the last ten years was calculated as follows: (0.021+0.044+0.045+0.048+0.042+0.04+0.037+0.036+0.038+0.035)/10
Stock of current Physicians in Heath System	Current Physicians in Heath System	Person	"G.P.Enter. Heath.Sys"+ "Spe.Enter.Health Sys"- "Out.Phys.Health Sys"	101847	12*84873300/10000=101847 According to the Rasa news agency, in the year 2021, the number of physicians per 10,000 people was reported to be 12 (33).
Per capita physician to population	Per capita physician to population	Person	(Current Physicians in Heath System/Population)*10000	-	-
Physicians leaving the health system	Out.Phys.Health Sys	Person	Current Physicians in Heath System*"Out.Phys.Healt h. Sys.Rate"	-	-
The rate of physicians leaving the health system	Out.Phys.Health. Sys.Rate	Percent	-	0.015	Based on the Focus Group Discussion (FGD)
Nurse	Nurse	Person	Current Physicians in Heath System*"Nurse.Rate"	-	-
Dentist	Dentist	Person	Current Physicians in Heath System*"Dent.Rate"	-	-
Pharmacologist	Pharmacologist	Person	Current Physicians in Heath System*"Pharm.Rate"		-

The presence rate of nurses in the health system	Nurse.Rate	Percent	-	1.5	The ratio of the number of practicing nurses to the number of practicing physician. The data pertaining to the number of practicing physician is derived from the report of the statistical system of the Medical System Organization in 2021 (32). The information regarding the number of practicing nurses is sourced from the Tasnim News Agency (34).
The presence rate of dentists in the health system	Dent.Rate	Percent	-	0.28	The ratio of the number of practicing dentists to the number of practicing physician is 41894 to 148426. This information is based on the report of the statistical system of the Medical System Organization (32).
The presence rate of pharmacologists in the health system	Pharm.Rate	Percent	-	0.19	The ratio of the number of practicing pharmacists to the number of practicing physician is 28050 to 148426. This information is based on the report of the statistical system of the Medical System Organization (32).
Demand and need for physicians in the outpatient department	Physician Demand for outpatient	Person	Burden of outpatient/Annual Working Capacity outpatient	-	-
Demand and need for physicians in the inpatient department	Physician Demand for Inpatient	Visit	Bed impatient Daily in annual/Annual Working Capacity inpatient	-	-
The annual working capacity of physicians in the outpatient department	Annual Working Capacity outpatient	Visit	Daily time work for outpatient*" Monthly time work-day for outpatient"* Visit Standard Time for outpatient*12	-	-

Standard number of visits for each outpatient service	Visit Standard number for outpatient	Visit	-	4	The duration of a visit varies depending on the type of physician. A visit to a general physician typically lasts 15 minutes, a specialist doctor 20 minutes, another type of specialist doctor (sub-specialty) 25 minutes, and a visit to a psychiatrist is usually 30 minutes (35). The standard duration for a visit is generally between 7 and 15 minutes. Therefore, a physician can typically accommodate between 4 to 8 visits per hour."
Working time spent per day for each outpatient service	Daily time work for outpatient	Hour	-	5	The average productive work activity for each physician is typically 5 hours per day.
Working time spent monthly for each outpatient service	Monthly time work-day for outpatient	Day	-	20	Given that the physician is allocated four working days each week, a total of twenty working days per month are taken into account.
The annual working capacity of physicians in the inpatient department	Annual Working Capacity inpatient	Person	(Visit Standard Time for inpatient*Daily time work for inpatient*"Monthly time work-day for inpatient")*12	-	-
Standard number of visits for each inpatient service	Visit Standard Time for inpatient	Visit	-	4	The standard duration of a visit typically ranges from 7 to 15 minutes, thus accommodating 4 to 8 visits per hour.
Working time spent per day for each inpatient service	Daily time work for inpatient	Hour	-	5	On average, each physician engages in productive work activities for a duration of five hours per day.
Working time spent monthly for each inpatient service	Monthly time work-day for inpatient	Day	-	20	Given that the physician is allocated four working days each week, a total of twenty working days per month are taken into account.
Demand rate for family physician	Family Physician rate	Percent	-	0.3	Tasneem News Agency (36)

Total demand and need for health system physicians	Total Physician Demand	Person	(Physician Demand for Inpatient+Physician Demand for outpatient)+ Family Physician rate*(Physician Demand for Inpatient+Physician Demand for outpatient)	-	-
The existing gap between the actual need for physicians and the existing physicians in the health system	Gap.Physician	Person	Total Physician Demand- Current Physicians in Heath System	-	-
The cost of training each general practitioner	Cost per GP	Rials	-	300000000	Tasnim News Agency 2021 (37)
The cost of training general practitioners	Cost GPs	Rials	Cost per GP*"G.P.St"	-	-
The cost of training each specialist doctor	Cost per specialist	Rials	-	500000000	The study of Nikjoo et al. in 2021 (38)
The cost of training each specialist doctor	Cost specialists	Rials	Cost per specialist*Specialist Students	-	-
The cost of training each student from other medical fields	Cost per other.st	Rials	-	200000000	Mehr news agency report in 2021 (39)
The cost of training each student from other medical fields	Cost other.st	Rials	"Cost per other.st"*"Other.Med.St"	-	-
The initial cost of	The initial cost	Rials	-	3224779540	National Health Accounts, 2019

training	of training			00000	(25) Estimation of the variable's value for the year 2021, based on the study conducted by Jahanmehr et al., 2022 (26)
Training costs	Training costs	Rials	Cost GPs+"Cost other.st"+Cost specialists+The initial cost of training	-	-

Appendix 6: Financing Parameters in Health System Modeling

Model parameters	Abbreviation of parameters	Unit	Calculation formula	The initial value of the parameter in 2021	Resource
Total outpatients	total outpatient	Person	Outpatient+ Outpatient1	-	-
The burden of outpatient visits	Burden of outpatient	Person	"Rate of burden-outpatient"* Total outpatient	-	-
Outpatient visits rate	Rate of burden-outpatient	Times	-	10	Statistical database of Iran Health Insurance Organization for 2021 (14) Statistical database of the Social Security Organization for the year 2021 (15)
Cost per outpatient	Cost per outpatient	Rials	-	2000000	Statistical database of Iran Health Insurance Organization for 2021 (14) Statistical database of the Social Security Organization for the year 2021 (15)
Total outpatient cost	Total outpatient cost	Rials	Burden of outpatient*Cost per outpatient	-	-
Total inpatients	Total inpatient	Person	Inpatient+Inpatient1	-	-
The burden of inpatient visits	Burden of inpatient	Person	Total inpatient*"Rate of burden-inpatient"	-	-
Inpatient visits rate	Rate of burden-inpatient	Times	-	1.5	Statistical database of Iran Health Insurance Organization for 2021 (14) Statistical database of the Social Security Organization for the year 2021 (15)
Cost per inpatient in the public sector	Public cost per inpatient	Rials	-	130000000	Tariff for diagnostic and treatment services approved by the Supreme Council of Health Insurance (40)
The gap between inpatient costs in the public and private sectors	Gap of public & private per cost	Rials	-	15000000	Tariff for diagnostic and treatment services in the private sector in 2021 (41)

Total inpatient cost	Total inpatient cost	Rials	(Burden of inpatient*Public cost per inpatient)+("Gap of public & private per cost"*Burden of inpatient)*0.3	-	-
The population receiving para clinical services	Paraclinc-popoulation	Person	Total inpatient+Total outpatient	-	-
The burden of referrals for diagnostic-pharmacological services	Burden of pharma-diag populaton	Person	"Rate of burden pharma-diag"*"Paraclinc-popoulation"	-	-
The burden rate of referrals for diagnostic-pharmaceutical services	Rate of burden pharma-diag	Times	-	0.67	Tariff for diagnostic and treatment services approved by the Supreme Council of Health Insurance (40)
The cost of each diagnostic-pharmaceutical service	Cost per service	Rials		12191900	Tariff for diagnostic and treatment services approved by the Supreme Council of Health Insurance (40)
The total cost of diagnostic-pharmaceutical services	Total pharma-diag cost	Rials	Cost per service*"Burden of pharma-diag populaton"	-	-
Total cost of medical care	Total cost of medical care	Rials	Total inpatient cost+Total outpatient cost+"Total pharma-diag cost"	-	-
Health cost	Health cost	Rials	"Rate.health cost"*Total cost of medical care		-
Percentage of cost spent in the health sector	Rate.health cost	Percent	-	0.08	National Health Accounts of 2019 (25) Estimation of the variable value in 2021 based on the study of

					Jahanmehr et al. in 2022 (26)
Infrastructural development and growth costs	Infrastructure costs	Rials	-	230548428000000	National Health Accounts of 2019 (25) Estimation of the variable value in 2021 based on the study of Jahanmehr et al. in 2022 (26)
Costs related to manpower education	Training costs	Rials	Cost GPs+"Cost other.st"+Cost specialists+The initial cost of training	-	-
The inflation rate in the health system	Inflation rate	Percent	-	0.25	Iran Statistics Center (42)
Administrative and logistic costs in the health system	Administrative & logistic cost	Rials	(Health cost+Total cost of medical care+Training costs+infrastucture investing)*" Rate.Administative & logistic cost"	-	-
Administrative and logistic costs rate in the health system	Rate.Administative & logistic cost	Percent	-	0.15	
Total cost	Total cost	Rials	Inflation rate*(Training costs+Total cost of medical care+Health cost+infrastucture investing)+(Training costs+Total cost of medical care+Health cost+infrastucture investing)+" Administrative & logistic	-	-

			cost"		
Gross Domestic Product	GDP	US $	GDP change rate*GDP per capita	-	-
GDP change rate	GDP change rate	Percent	-	0.027	The World Bank 2022 (43)
GDP per capita	GDP per capita	US $	Total GDP/Population	-	-
Total GDP	Total GDP	US $	GDP	388544468140	The World Bank 2022 (44)
Share of health system in GDP	Share of health system	Percent	-	0.053	The Central Bank of the Islamic Republic of Iran (45)
Exchange rate	Exchange $	Rials	-	298280	The Central Bank of the Islamic Republic of Iran (46)
The total budget allocated to the health sector	THE	Rials	(Total GDP*Exchange $*Share of health system)	-	-
The existing gap between the actual costs and the budget considered in the health sector	Gap of health expenditure	Rials	THE-Total cost	-	-

Appendix 7: Potential Scenarios in Iran's HS

Scenario builders	Coefficients of change in each scenario	Desirable scenario	Intermediate scenario	Undesirable scenario
The ratio of physicians to the population per 10,000 people	-	20.08 (220800)	16.01 (160100)	12.03 (108300)
	1.1 Admission rate of medical students (Med.St.Rate)	0.04	0.035	0.012
	1.2 Admission rate of general physician students in specialized fields (Spe.St.Rate)	0.08	0.078	0.047
	1.3 The entry rate of specialists into the HS (Spe.Enter.Heath Sys.Rate)	0.10	0.064	0.030
	1.4 The rate of entry of graduated general practitioners into the HS (G.P.Enter.Heath.Sys.Rate)	0.145	0.071	0.030
The ratio of beds to population per thousand people	-	3.104 (341400)	2.513 (251300)	2.177 (196000) (16)
	The rate of growth and development of the bed (Bed.Dev.Rate)	0.1079	0.071	0.042
The ratio of medical equipment to the population per million people	-	46.72 (5138)	35.03 (3503)	30.04 (2705)
	The rate of growth and development of medical equipment (M.E.R.rate)	0.1308	0.084	0.0535
Health inflation rate	-	0.25	0.35	0.4
Exchange rate	-	280000	298280	400000
The share of the HS in the GDP	-	0.07	0.06	0.045
GDP growth rate		0.088	0.017	-0.037
Exposure to risk factors	-	0.20	0.35	0.45
Population change coefficient	-	110000000	100000000	90000000
	Birth Rate	0.0356	0.0248	0.013
Management and support costs rate in the HS	-	0.1	0.15 (50)	0.2

Desirable per capita physician in Iran: 20 per 10,000 populations (47)

In terms of hospital beds, the global average stands at 3.1 beds per thousand individuals (48). The number 2.19 is derived from an article by Haghdoost et al. (16).

In 2021, the desirable per capita hospital bed ratio in Iran was reported to be 2.5 (49).

Regarding the GDP growth rate, the rate published by the World Bank (43) was utilized as the baseline for calculating its 15-year period rate in three scenarios: desirable, intermediate and undesirable. The highest percentage of GDP was attributed to the desirable scenario, the average percentage values from the last 15 years were included as a percentage of GDP in the intermediate scenario, and the lowest percentage was assigned to the undesirable scenario.

Regarding the ratio of medical equipment to the population, the study by Aghajani et al. (20) used a base ratio of 13.8 in 2015 and 23.67 in 2014. By calculating the annual growth rate and obtaining a factor of 1.097, the growth rate for 2031 was determined to be 16.455 (calculated as 15 × 1.097). Adding this growth to the initial ratio of 13.8 resulted in the projected ratio for the year 2031, which is 46.72.

Appendix 8: Change of parameters associated with health-related risk factors in each scenario, in order of the possibility of greater variability in the next ten years

Scenario builders	Desirable scenario while considering the risk factors related to health = 0.2	Intermediate scenario while considering the risk factors related to health=0.35	Undesirable scenario while considering health-related risk factors=0.45
Community nutrition status	0.0046	0.0196	0.0326
Physical activity level of people	0.0008	0.0098	0.0198
The state of obesity among people	0.0039	0.0189	0.0279
The rate of high blood pressure in the community	0.01335	0.02835	0.03785
High blood sugar levels in the community	0.004175	0.014175	0.023375
High blood cholesterol levels in the community	0.020075	0.033075	0.041075
Depression rate of society	0.0125	0.0245	0.0316
The rate of violence among individuals	0.0008	0.0098	0.0148
The rate of high-risk sexual behaviors	0.0047	0.0147	0.0214
Drug addiction rate	0.0096	0.0196	0.0246
Natural and environmental hazards	0.0305	0.0385	0.0425
Social factors related to lifestyle	0.02996	0.03696	0.03996
Economic factors related to lifestyle	0.01888	0.02688	0.03088
Cultural factors related to lifestyle	0.01616	0.02016	0.02166
HS inefficiency	0.03	0.035	0.040

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