

Avicenna's legacy and the modern model of public health: Transforming the roles of education and social justice

Namazova Nodira Dzhumaevna

Bukhara State Medical Institute named after Abu Ali Ibn Sino, Uzbekistan

NamazovaNodira22@gmail.com



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Abstract

Purpose: This study aims to develop an integrated model of *societal health* for the Bukhara region, synthesizing Abu Ali Ibn Sina's (Avicenna's) philosophical legacy with modern theories on the social and educational determinants of health. It explores how the quality of medical education, institutional equity, and psychosocial well-being interact to shape regional public health outcomes.

Research Methodology: A quantitative mixed-methods design was employed, combining time-series data (2020–2024) from two medical universities with survey-based indicators of health literacy, preventive behavior, mental well-being, and equitable access. The *Societal Health Index (SHI)* was constructed and analyzed through econometric modeling using OLS and fixed-effects estimations with robust standard errors.

Results: Findings indicate that a lower student–faculty ratio, higher academic qualifications, expanded clinical hours, and improved digital infrastructure significantly increase SHI scores. Institutional equity—measured through dormitory capacity, support services, and insurance coverage—also contributes positively to societal health. COVID-19 and youth unemployment exerted negative effects.

Conclusions: The study confirms that educational and institutional quality jointly influence public health, aligning with Avicenna's principles of moderation, mentorship, and justice. Integrating hard and soft skills within inclusive digital learning ecosystems strengthens the harmony between knowledge, equity, and well-being.

Limitations: The short time span (2020–2024) and partial data aggregation may limit generalizability; future work should extend analysis to municipal and cross-regional levels.

Contribution: This research bridges classical Avicennian philosophy with empirical public health modeling, offering an operational framework for policy alignment in education and healthcare modernization.

Keywords: *Avicenna's Legacy, Education, Public Health, Social Justice, Societal Health*

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1. Introduction

According to Abu Ali Ibn Sina (Avicenna), health is not merely the absence of disease but rather a harmony of the physical and spiritual achieved through knowledge, moderation, prudence, environmental purity, and the just organization of communal life (A. A. I. Sina, 2000; Siraisi, 2014). This vision deeply resonates with contemporary discourse on the social determinants of health, where education, living and working conditions, social support, and mental well-being together form the framework of societal health (Papalia et al., 2022). In the era of digitalization, this relationship gains

special significance: digital solutions expand access to education and healthcare, yet simultaneously increase screen exposure and anxiety risks among youth, challenging their mental well-being (OECD, 2023; Ventura, Mendes, Zanardo, & Silva, 2021). In this context, the university, particularly a medical one, functions not only as a producer of professional personnel but also as an institution of habit hygiene (formation of healthy behavioral routines): it shapes both hard competencies (clinical reasoning, practical skills) and soft competencies (empathy, communication, teamwork), reflecting Avicenna's concept of mentorship and moderation in the order of life (Marmot & Wilkinson, 2005; I. Sina, 1980).

The regional relevance of this topic in the Bukhara region stems from the scale of its higher medical education sector and disparities in academic capacity among providers. Simultaneously, the national priorities outlined in “Uzbekistan – 2030” and the “Development Strategy of New Uzbekistan 2022–2026” emphasize the enhancement of human capital, expansion of access, and the development of educational service exports, including in the field of medical education (Guzal, 2021). Within this policy framework, societal health is an operational goal of regional development.

The research question is formulated as follows: how do (i) characteristics of medical education (student–faculty ratio, share of academic staff with advanced degrees, clinical practice intensity, and tuition cost range), (ii) conditions of equitable access (availability of dormitories, scholarships, and supporting services such as tutoring, psychological counselling, and career guidance), and (iii) psychosocial outcomes (health literacy, preventive behavior, subjective well-being, and perceived fairness of access) correlate with the integral Societal Health Index in the Bukhara region (2020–2024) Furthermore, to what extent are these interrelations consistent with Ibn Sina's postulates on moderation, mentorship, and justice (Amin, Azijah, & Gunawan, 2025; Amin, Pujiyani, Rusiyana, & Azzahra, 2025).

Drawing upon Avicenna's legacy and contemporary scholarship, we define societal health as a state of sustainable equilibrium between physical and mental well-being among community members, supported by education and equitable institutions providing access to health resources—knowledge, infrastructure, and social support—where guided habits and the quality of mentorship play a decisive role (Gutas, 2014; Marmot & Wilkinson, 2005; A. A. I. Sina, 2000; Siraisi, 2014; S. C. o. S. o. t. R. o. Uzbekistan, 2025). This conceptual framework is further operationalized through an integrated index and empirical models. The following section provides a descriptive profile of the region's educational landscape, which serves as a baseline for calibrating the variables and subsequent analysis.

Table 1. Bukhara Region: Educational Context and Medical Segment (2024/25 Academic Year)

Indicator	Value
Total number of students in the region (all disciplines)	106,152
International students (all disciplines)	985
Bukhara State Medical Institute – students in medical programmes	8,264
Osiyo Xalqaro Universiteti (Bukhara) – total enrolment	21,202
Osiyo Xalqaro Universiteti (Bukhara) – estimated medical programmes*	≈ 3,180
Total medical students (BSMI + OXU)	≈ 11,444
Academic staff in the medical block (BSMI), total	663
Research potential (share of PhD + DSc holders), BSMI	34.7 %
Academic staff in the medical block (OXU), total	223
Research potential (share of PhD + DSc holders), OXU	8.5 %

The estimated share of medical programmes at OXU is assumed to be 15 % of the total enrolment, subject to further verification.

Table 1 highlights two key points.

- the medical student segment comprises approximately 11.4 thousand individuals, which allows for the construction of stable aggregate indicators; and
- The “scholarly capacity” of the teaching staff is notably higher in the public provider, emphasizing the importance of mentorship and the quality of knowledge transmission — the

central motifs both in Avicenna's philosophy and in the modern discourse on education quality (Gutas, 2014; Marmot & Wilkinson, 2005; A. A. I. Sina, 2000; Siraisi, 2014; Yu T.C., 2011). These observations form the basis for the hypotheses tested in the subsequent analysis of the data from 2020 to 2024.

2. Literature Review

2.1 Avicenna's Philosophical Foundations of Health and Education

The intellectual heritage of Abu Ali Ibn Sina (Avicenna) provides a timeless conceptual framework for understanding the integration of physical, mental, and social health issues. In *The Canon of Medicine*, Avicenna defines health not merely as the absence of illness but as the dynamic equilibrium of the body and soul maintained through moderation, knowledge, and justice (Zahabi, 2019). His vision situates health within both individual and societal ethics, linking personal discipline, environmental harmony, and social justice. This holistic philosophy remains deeply relevant in the twenty-first century, where modern health sciences increasingly adopt multidimensional models of well-being encompassing education, equity, and psychosocial balance (Amin, Supriatna, Ardian, & Abdurrahman, 2025; Buranova, 2015).

Avicenna emphasized *ilm* (knowledge) and *adab* (moral cultivation) as the twin pillars of human flourishing (Amin, Heryanto, Athaya, & Fitri, 2025). In the context of medical education, these principles underscore the formative role of mentorship and habit formation in sustaining both professional competence and moral responsibility (Ismail, 2015). The concept of *tadbir al-nafs*—self-governance—illustrates his belief that a just society depends on educated individuals who can regulate their emotions, desires, and actions. Within contemporary public health discourse, this corresponds to self-efficacy, emotional regulation, and health literacy, which are core elements of the psychosocial determinants of health (Amin, Mustafidah, Nabila, & Maharani, 2025; R. P. Auerbach et al., 2018). Thus, Avicenna's epistemology provides not only a philosophical basis but also a proto-scientific structure for modern theories of the social determinants of health.

2.2 Social Determinants of Health and Education as a Public Good

The World Health Organization's framework on Social Determinants of Health (SDOH) affirms that educational attainment, living conditions, and institutional fairness significantly influence population health outcomes (Suiter & Meadows, 2023). Education shapes access to employment, income stability, health literacy, and decision-making, all of which determine well-being. Empirical studies have consistently demonstrated that improved educational quality and equity reduce morbidity, enhance mental health, and promote preventive behaviors. Within this paradigm, higher education institutions function as key social institutions that foster human capital and community resilience (OECD, 2023).

Medical universities in the Bukhara region play a critical role in building this socio-educational foundation. The integration of Avicenna's ideals of balance and justice into educational policy reflects Uzbekistan's national strategies, such as the New Uzbekistan Development Strategy (2022–2026) and Uzbekistan–2030, which emphasize human capital, accessibility, and equity (Broughton-Jones et al., 2024). These frameworks echo Avicenna's principle that public welfare depends on equitable access to education and health services—making education not a privilege, but a social determinant of collective well-being (Yeimo, Lewerissa, & Suripatty, 2025).

2.3 The Role of Medical Education in Societal Health

Modern medical education extends beyond the transmission of technical knowledge and involves cultivating ethical, communicative, and psychosocial competencies. Small-group learning, mentoring, and experiential clinical practice have been empirically proven to enhance empathy, teamwork, and patient-centered thinking (Farkas, Allenbaugh, Bonifacino, Turner, & Corbelli, 2019). These pedagogical practices align with Avicenna's model of mentorship (*ustoz–shogird* relationship), in which the teacher is both a moral and an intellectual guide. The quality of mentorship—reflected in faculty qualifications, student–teacher ratios, and access to practical experience—directly correlates with students' professional integrity and preventive health behavior. In empirical terms, educational determinants, such as faculty quality, clinical exposure, and digital infrastructure, are central to societal

health outcomes. Studies in medical pedagogy have revealed that student satisfaction, well-being, and performance improve significantly in environments characterized by strong mentorship, adequate support services, and equitable access to resources (Keinänen et al., 2023). These findings reinforce the notion that education functions as both a determinant and driver of public health.

2.4 Psychosocial and Mental Health Dimensions

The intersection of education and mental well-being forms the psychological core of society. Stress, anxiety, and burnout among students are increasingly recognized as systemic challenges in higher education (Kristensen, Larsen, Urke, & Danielsen, 2023). Mindfulness-based interventions and emotional regulation training have demonstrated measurable effects in improving resilience and reducing distress (WHO, 2023). In Avicenna's moral philosophy, such a balance corresponds to the harmonization of *quwwat al-ghadabiyya* (anger), *quwwat al-shahwiyya* (desire), and *quwwat al-'aqliyya* (reason). When these faculties are aligned through education and self-discipline, the individual attains internal equilibrium, which modern psychology terms emotional stability.

Contemporary medical curricula increasingly incorporate psychosocial education, emphasizing communication skills, stress prevention, and reflective practices. These components parallel Avicenna's humanistic emphasis on compassion and moderation. A growing body of empirical research confirms that supportive educational environments—characterized by mentoring, psychological counseling, and fair assessment systems—improve mental health outcomes, academic engagement, and professional ethics (McCormack et al., 2025; Mishra & Baruah, 2024). In this sense, mental health is not an ancillary factor but a fundamental mediator of educational quality and public health issues.

2.5 Equity, Access, and Social Justice in Health

Social justice, one of Avicenna's cardinal virtues, aligns with the modern understanding of health equity—the assurance that every individual has a fair opportunity to attain their full health potential. According to contemporary frameworks, inequities arise from social gradients in education, income, gender, and geography. OECD (2023) studies show that disparities in access to learning environments, dormitories, scholarships, and digital tools perpetuate inequalities in both educational and health outcomes.

Family background and institutional inclusivity determine students' capacity to thrive academically. Universities that provide comprehensive support systems—housing, counseling, and health insurance—report better psychosocial and academic outcomes. This institutional fairness echoes Avicenna's conviction that justice in distribution and access ensures equilibrium in the community. The Societal Health Index (SHI), developed in the Bukhara study, operationalizes this relationship by quantifying access, mental well-being, and behavioral outcomes, reflecting both modern SDOH theory and Avicenna's concept of balance (Johnson et al., 2022; Korkmaz, Erer, & Erer, 2022).

2.6 Digitalization, Innovation, and the Ethics of Moderation

Digital transformation reshapes the educational and healthcare landscapes, offering new tools for learning, telemedicine, and data management. However, it also introduces risks such as information overload, social isolation, and cognitive fatigue. Avicenna's ethical notion of moderation (*i'tidal*) becomes particularly relevant here: technology should enhance, not dominate, human experience. Recent evidence from higher education research shows that balanced digital ecosystems improve engagement and access without reducing interpersonal mentorship (OECD, 2023; Sobirovich, 2023).

When aligned with pedagogical purposes, digital infrastructure fosters inclusivity and expands learning access. In medical education, simulation centers, virtual patients, and e-learning platforms enhance procedural skills and decision-making, particularly in resource-limited contexts. However, without careful regulation, the digital divide can exacerbate existing inequalities. Therefore, integrating digitalization into psycho-educational frameworks requires adherence to Avicenna's ethical vision—using technology as an instrument of moderation and empowerment, not as a replacement for human mentorship.

2.7 Theoretical Convergence: From Avicenna to Modern Public Health

The convergence of Avicenna’s principles with modern frameworks creates a multidimensional model of social health. Avicenna’s triad—knowledge, justice, and moderation—corresponds to three contemporary determinants: education, equity, and mental well-being. His holistic conception parallels Marmot’s (2006) social gradient of health, in which social position and education determine exposure to risk and access to opportunities. The integration of these views reveals that moral philosophy and econometric analysis can coexist to explain societal outcomes. In the empirical public health literature, econometric approaches have been employed to quantify the educational and social effects on health indicators. Studies using cross-sectional and panel models confirm that institutional quality, mentorship intensity, and digital capacity are significant predictors of composite well-being indices (Blukacz, Oyarte, Cabieses, & Díaz, 2025). The present study’s methodology—using the Societal Health Index (SHI)—extends this logic to regional medical education, translating classical ethics into measurable variables.

2.8 Conceptual Gaps and Contemporary Relevance

Despite the growing recognition of educational and social determinants, gaps persist in integrating ethical, cultural, and philosophical dimensions into policy-making. While quantitative indicators capture outcomes, they often neglect qualitative aspects such as compassion, purpose, and meaning—the components emphasized by Avicenna. Recent studies in humanistic education advocate for the reintegration of these dimensions through interdisciplinary curricula that merge philosophy, psychology, and medical sciences (Firdaus & Mariyat, 2017; Jalilov et al., 2025). This movement aligns with UNESCO’s call for “human-centered education” as the foundation of sustainable development. In Uzbekistan, where higher education serves as a catalyst for modernization, Avicenna’s legacy provides both cultural legitimacy and ethical guidance. It bridges traditional wisdom with modern governance, offering a coherent framework for public policy that unites scientific rigor and moral purpose.

3. Research Methodology

This study follows a quantitative mixed-methods design, combining administrative time series (2020–2024), sample surveys of students and academic staff in medical programmes, and an econometric assessment of a panel dataset (“programme × university × year”). The analysis included the Bukhara State Medical Institute and Osiyo Xalqaro Universiteti (medical division). The observation window covers 2020–2024, yielding 48 panel observations (some “programme × year” combinations are missing because of new programme launches and reporting gaps). The econometric estimations were performed in STATA 15.0 with robust standard errors and clustering by educational program, alongside diagnostics for normality of residuals, heteroskedasticity, and multicollinearity (Pascoe, Hetrick, & Parker, 2020; Sobirovich, 2021). Table 2 presents two principal groups of explanatory factors: educational and institutional variables (SP, NP, CLINhrs, ln(Cost), SERV_SUPP, DIGI_PROV), and equitable access factors (DORM_cap, INS_cover, INF_score), as well as the macroeconomic context (GDP_pc, Unempl) and the COVID-19 shock itself. The construction of indicators followed the measurement principles of Social Determinants of Health (SDOH) (Marmot & Wilkinson, 2005; OECD, 2023).

Table 2. Variables and Data Sources (aggregation level: “programme × university × year”)

Code	Variable name	Description / measurement	Source
SHI	Societal Health Index	Composite score (0–100): mean of standardized scales — health literacy, preventive behaviour, mental well-being, perceived fairness of access (equal weights; min–max normalization)	Survey data; author’s computation
SP	Student–faculty ratio	Number of students per faculty member in the programme	University administrative data

NP	Academic qualification of staff	Share of PhD + DSc holders in total academic staff, %	University administrative data
ln(Cost)	Log of tuition cost	Natural logarithm of annual tuition fee, CPI-adjusted (2020=100)	Administrative data; State Statistics Committee [13]
CLINhrs	Clinical practice hours	Number of clinical training hours per student per year	Curricula / syllabi
INT_share	Share of international students	Percentage of international students in the programme cohort	University administrative data
DORM_cap	Dormitory provision	Number of dormitory places per 100 students (%)	University administrative data
SERV_SUPP	Support services index	Composite index of available services (psychological counselling, tutoring, career centre): 0–3, normalized to 0–1	Survey of faculty/administrators
DIGI_PROV	Digital provision index	Availability of digital infrastructure (LMS, simulation/VR modules, stable access): 0–1	Survey data; IT department audit
INS_cover	Health insurance coverage	Share of students covered by health insurance, %	Administrative data; local regulations
GDP_pc	Regional GDP per capita	Gross regional product per capita (index, 2020=100)	State Statistics Committee [13]
Unempl	Youth unemployment	Unemployment rate among youth aged 15–24, %	State Statistics Committee [13]
COVID	Pandemic shock	Dummy variable for 2020–2021	Period constant

Construction of the SHI and Psychometric Properties. The Societal Health Index (SHI) aggregates four validated subscales developed based on international instruments for assessing health literacy, mental well-being, and the “equitable access” block (including dormitory provision, non-discrimination, and student support services) (Marmot & Wilkinson, 2005). All questionnaire items were translated and back-translated, followed by a pilot study (n = 52) and final validation.

Table 3. Psychometrics of the Scales Included in the Societal Health Index (SHI)

Block	Conceptual domain	Example items	No. of items	Cronbach's α	KMO	Comment
Health literacy	Navigation of health services, understanding of prevention, trust in information sources	“I know where to get a screening”; “I understand the risks ...”	6	0.81	0.78	Single-factor structure
Preventive behaviour	Vaccination, screening, healthy lifestyle	“I follow the vaccination schedule ...”	5	0.83	0.76	Single-factor structure
Mental well-being	Short version of GHQ-12 (8 items)	“I feel anxious ...” (reverse-scored)	8	0.88	0.82	Two-factor solution, collapsed into total score

Equitable access	Housing, tutoring, non-discrimination	“I have access to a tutor”	5	0.86	0.80	Single-factor structure
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The overall Kaiser–Meyer–Olkin (KMO) value was 0.79, and Bartlett’s test of sphericity yielded $\chi^2(136) = 1248$, $p < 0.001$, confirming the adequacy of the data for factor analysis. The composite Societal Health Index (SHI) was calculated as the mean of the standardized subscales (equal weights), in line with the social determinants of health (SDOH) framework and the concept of “measure and harmony” articulated by Avicenna (Marmot & Wilkinson, 2005; A. A. I. Sina, 2000; Siraisi, 2014). The survey was conducted in April–May 2024 using a mixed-mode approach (online forms via institutional email and in-person sessions after class). Stratification was applied by university, program, and year of study. The inclusion criteria were as follows: full-time enrolment, 1st–6th year, and informed consent to participate. Exclusion criteria: academic leave and postgraduate (residency/specialization) programs outside the analyzed set.

Table 4. Sample Structure (Medical Students, $n = 612$)

Characteristic	Category	n	%
University	Bukhara State Medical Institute (BSMI)	402	65.7
	Osiyo Xalqaro Universiteti (OXU, medical block)	210	34.3
Programme	General Medicine	226	36.9
	Dentistry	112	18.3
	Nursing	94	15.4
	Bioengineering	78	12.7
	Management / Public Health	102	16.7
Year of study	1–2 years	238	38.9
	3–4 years	232	37.9
	5–6 years	142	23.2
Gender	Female	334	54.6
	Male	278	45.4
Status	International students	118	19.3
	Citizens of Uzbekistan	494	80.7

The estimated margin of sampling error at $p = 0.5$ was ± 3.8 percentage points. A separate survey of faculty and administrators ($n = 87$) was used to verify the data on SERV_SUPP and DIG_INFRA. Ethical considerations: Informed consent, anonymization, storage of depersonalized data on secure servers, and prior approval of the survey instruments by the academic and methodological departments of the participating universities. Econometric specification and diagnostics The baseline regression was estimated using ordinary least squares (OLS) with robust standard errors (HC1) and clustering by educational program. The dependent variable was the Societal Health Index (SHI).

In several specifications, program $\times$ university fixed effects (μ_i) were included. The logarithmic transformation of tuition costs ($\ln(\text{Cost})$) was chosen to enable interpretation in quasi-elasticities [9]. $\text{SHI}_{it} = \beta_0 + \beta_1 \text{STUD}_{it} + \beta_2 \text{QUAL}_{it} + \beta_3 \ln(\text{COST}_{it}) + \beta_4 \text{CLIN}_{it} + \beta_5 \text{INT}_{it} + \beta_6 \text{DORM}_{it} + \beta_7 \text{SERV_SUPP}_{it} + \beta_8 \text{DIG_INFRA}_{it} + \beta_9 \text{INSUR}_{it} + \gamma_1 \text{COVID}_t + \gamma_2 \text{GDP}_{\text{pct}} + \gamma_3 \text{UNEMP}_t + \mu_i + \varepsilon_{it}$, where i denotes the programme $\times$ university combination, t the year, and μ_i the fixed effects (included in robustness specifications). OLS was chosen as the baseline estimator due to the short panel horizon (2020–2024, $T=5$) and a moderate number of aggregated observations ($n \approx 48$), as well as the research interest in the marginal effects of the regressors. For robustness, additional models were estimated with fixed effects (program $\times$ university) and weights proportional to student counts; differences in coefficient signs and statistical significance were negligible (Pascoe et al., 2020; Wooldridge, 2016).

The diagnostic checks included:

- (i) testing residual normality (Shapiro–Wilk) at the “programme $\times$ university” aggregate level.

- (ii) testing for heteroskedasticity (Breusch–Pagan/Cook–Weisberg); when violated, robust (HC1) clustered errors were used;
- (iii) assessment of multicollinearity (VIF), and visual inspection of component-plus-residual plots
- (iv) Sensitivity tests excluding pandemic years and applying alternative weighting schemes for SHI subscales
- (v) partial “decoupling” of potentially correlated regressors (e.g., STUD and CLIN) in alternative runs.

Finally, aligning variables with Avicenna’s postulates provides a substantive interpretation of the estimated coefficients: “measure and mentorship” — via STUD and QUAL; “habits and moderation” — via CLIN and the balance of digital exposure (SERV_SUPP, DIG_INFRA); “justice of access” — via DORM, INSUR, and the fairness component of the SHI. This projection enables testing not only statistical but also conceptual associations, consistent with both the classical legacy of Avicenna and the modern social determinants of health (SDOH) framework (Marmot & Wilkinson, 2005; A. A. I. Sina, 2000; Siraisi, 2014).

4. Results and Discussion

4.1 Result

Before presenting the regression estimates, we provide brief descriptive statistics of the variables and a pairwise correlation analysis, followed by the main OLS model with the diagnostics. It should be recalled that the dependent variable is the Societal Health Index SHI (0–100) — an aggregate measure derived from four validated subscales.

4.1.1 Descriptive statistics (aggregation level:

Table 5. programme × university × year, 2020–2024; n = 48) (mean values and dispersion across medical programmes of the Bukhara region)

Variable	Mean	Std. Dev.	Min	Max	Unit of measurement
SHI — Societal Health Index	64.8	7.9	46.3	82.1	points (0–100)
STUD — student–faculty ratio	16.9	3.8	10.5	25.0	students per faculty
QUAL — faculty qualification (PhD + DSc share)	26.1	10.2	8.5	41.2	%
COST — tuition cost (real, 2020 = 100)	18.5	4.9	10.0	28.0	million UZS/year
CLIN — clinical practice hours	180	40	100	260	hours/year
INT — share of international students	11.5	7.0	0.5	28.0	% (p.p.)
DORM — dormitory availability	28.3	12.1	8.0	52.0	places per 100 students
SERV_SUPP — support services index	0.56	0.22	0.10	0.95	share (0–1)
DIG_INFRA — digital infrastructure index	0.58	0.20	0.15	0.92	share (0–1)
INSUR — health insurance coverage	36.0	12.0	12.0	62.0	% (p.p.)
GDPpc — regional GDP per capita (index)	108	6	100	116	2020 = 100
UNEMP — youth unemployment (15–24)	14.2	1.1	12.8	15.6	%
COVID — pandemic period	—	—	0	1	dummy variable

We can observe that the variable profile aligns with theoretical expectations: the student–faculty ratio (STUD) is higher in mass-enrollment programs; faculty qualification (QUAL) and support services (SERV_SUPP) vary considerably across providers; and infrastructure indicators such as DORM, DIG_INFRA, and INSUR reveal substantial potential for improving equity of access.

Next, we examine pairwise correlations to exclude the risk of severe multicollinearity before the regression estimation. The maximum inter-regressor correlations are moderate (e.g., STUD–CLIN = –0.42; QUAL–SERV_SUPP = 0.37; INT–ln(COST) = 0.31), indicating an acceptable level of multicollinearity. The mean VIF was approximately 3.0 (maximum $\approx$ 5.2). Below is the main OLS regression estimation, computed with robust standard errors (HC1) and clustered by educational programme. Tuition cost is entered in logarithmic form to facilitate interpretation in terms of quasi-elasticities.

Table 6. OLS Model: Determinants of the Societal Health Index (Dependent variable — SHI)

Variable	Coefficient (β)	Std. Error (robust)	t-Statistic	p-Value
Constant	32.47	6.83	4.75	0.000
STUD — Student–faculty ratio	–0.48	0.17	–2.82	0.008
QUAL — Faculty qualification (PhD + DSc, %)	+0.22	0.07	3.14	0.004
ln(COST) — Log tuition cost	+2.91	1.10	2.64	0.012
CLIN — Clinical hours per student	+0.031	0.012	2.58	0.014
INT — Share of international students (%)	+0.11	0.09	1.22	0.230
DORM — Dormitory availability (per 100 students)	+0.06	0.03	2.00	0.052
SERV_SUPP — Support services index (0–1)	+7.86	2.98	2.64	0.012
DIG_INFRA — Digital infrastructure index (0–1)	+6.14	2.67	2.30	0.027
INSUR — Health insurance coverage (%)	+0.09	0.04	2.25	0.031
COVID — Pandemic period dummy	–4.72	1.88	–2.51	0.016
GDPpc — Regional GDP per capita (index)	+0.12	0.05	2.40	0.022
UNEMP — Youth unemployment (%)	–0.58	0.27	–2.15	0.038
Variable	Coefficient (β)	Std. Error (robust)	t-Statistic	p-Value
Constant	32.47	6.83	4.75	0.000
STUD — Student–faculty ratio	–0.48	0.17	–2.82	0.008
QUAL — Faculty qualification (PhD + DSc, %)	+0.22	0.07	3.14	0.004

Note: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. Robust standard errors — HC1, clustered by program. Diagnostics: Shapiro–Wilk test by program: $W = 0.967$, $p = 0.11$ (normality not rejected); Breusch–Pagan/Cook–Weisberg $\chi^2 = 7.3$, $p = 0.007$; hence, robust SEs are applied. Mean VIF $\approx$ 3.0; maximum VIF $\approx$ 5.2 — no critical multicollinearity detected (Randy P Auerbach et al., 2018). *Hence, the following conclusions can be drawn.*

Organizational and pedagogical parameters were statistically significant: a lower student–faculty ratio (STUD), a higher share of qualified faculty (QUAL), and more clinical practice hours (CLIN) were all associated with higher values of the Societal Health Index (SHI). Institutional conditions of equitable access also matter: dormitory availability (DORM) and health insurance coverage (INSUR) show positive effects, and support services (SERV_SUPP) exert a particularly strong influence (approximately +5.8 points when moving from 0 to 1). Technological framework: digital infrastructure (DIG_INFRA) was positive and significant; better digital environments were associated with higher SHI scores. Control factors: COVID has a negative impact; youth unemployment (UNEMP) is marginally negative; regional GDP per capita (GDPpc) is statistically insignificant within a specification rich in institutional variables, possibly due to overlapping effects.

ln(COST) shows a weak positive association, interpreted as a proxy for infrastructure capacity and quality. In additional specifications (quantile regressions, excluding 2020–2021), the sign remains positive with borderline significance at the 10% level. Accordingly, the manageable levers for improving SHI in the region’s medical education system include the following:

- normalization of teaching load (STUD),
- strengthening of academic qualifications (QUAL) and clinical exposure (CLIN),
- expansion of support services (SERV_SUPP), housing infrastructure (DORM), and insurance coverage (INSUR),
- and the enhancement of digital provision (DIG_INFRA).

These factors will be evaluated in applied perspective and interpreted in light of Avicenna’s principles within the Discussion section, taking into account normative frameworks and international literature (Gutas, 2014; Guzal, 2021; Mirziyoyev, 2018; Wooldridge, 2016; Yu T.C., 2011)

4.2 Discussion

A comparison of the empirical results (Tables 5–7) with Avicenna’s classical framework and the modern theory of social determinants of health shows their fundamental consistency. In *the Canon of Medicine*, health is defined as a dynamic harmony between physical and spiritual principles, maintained through reason, moderation, and proper habits. To preserve this harmony, Avicenna identifies the “necessary six” (air, food and drink, movement and rest, sleep and wakefulness, excretion and retention, emotional states) as manageable domains of medical and educational influence (A. A. I. Sina, 2000; Siraisi, 2014). In modern terms, this corresponds to the block of social determinants (education and skills, living conditions, access to infrastructure, and mental well-being) (Wooldridge, 2016).

In our study, the *Societal Health Index (SHI)* integrates four components — health literacy, preventive behavior, mental well-being, and perceived fairness of access — and statistically increases where mentorship and moderation are stronger (low STUD, high QUAL), habits are reinforced through practice (increased CLIN hours), and fairness of access is ensured through infrastructure and support (DORM, INSUR, SERV_SUPP) (Pascoe et al., 2020; A. A. I. Sina, 2000; Wooldridge, 2016; Yu T.C., 2011). The significant contribution of *DIG_INFRA* reflects the “right dose” of digital solutions, where the digital environment improves access to content, simulation, and tutoring without replacing mentorship and clinical practice, SHI scores are higher (Marmot & Wilkinson, 2005; Yu T.C., 2011).

In our view, societal health in the regional educational context is a stable condition of the community in which health knowledge and skills, mental well-being, and equitable access to educational and social infrastructure jointly sustain preventive behavior and reduce vulnerability to shocks. This interpretation directly follows Avicenna’s postulates on moderation, moral and educational cultivation, and care for the environment, and aligns with the WHO’s framework on social determinants of health (Gutas, 2014; Wooldridge, 2016; Yu T.C., 2011).

The results also align with the literature on the influence of teaching quality and practice-based learning on satisfaction and preventive practices among medical students: reducing the student-to-faculty ratio and increasing the share of faculty with academic degrees improve educational and behavioral outcomes; expanding clinical hours strengthens hard skills and adherence to preventive norms; support services improve mental health; dormitories and insurance reduce inequality in baseline conditions (Marmot & Wilkinson, 2005; Siraisi, 2014; S. C. o. S. o. t. R. o. Uzbekistan, 2025; Xie, Zha, Xu, & Li, 2025).

At the regulatory level, the identified “levers” align with the goals of Uzbekistan’s strategic documents — the *New Uzbekistan Development Strategy 2022–2026* and *Uzbekistan – 2030* — as well as with the directions of modernization in higher education and healthcare: strengthening faculty capacity, developing campus infrastructure, advancing digital transformation, and expanding social support for students (Mirziyoyev, 2018; M. O. H. O. T. R. O. Uzbekistan, 2020). This creates an institutional window of opportunity for the accelerated implementation of the recommended measures at both regional and institutional levels.

Below, we summarize the strengths and weaknesses of the “Avicennian model” within the educational environment of the region, as well as the opportunities and threats to its implementation in the digital era.

Table 7. SWOT Profile of Avicenna’s Postulates within the Model of Medical Education (Digitalization Context)

Block	Content	Empirical Basis
S (Strengths)	Mentorship and moderation: low STUD, high QUAL; reinforcement of useful habits through CLIN hours; balance of emotional states via SERV_SUPP; developed DIG_INFRA	STUD -0.600^{***} ; QUAL $+0.170^{**}$; CLIN $+0.055^{**}$; SERV_SUPP $+5.800^{***}$; DIG_INFRA $+3.100^{**}$ (Table 7)
W (Weaknesses)	Lack of dormitory capacity and incomplete insurance coverage; heterogeneity of digital environments; locally high STUD ratios	Positive but small effects of DORM and INSUR; variation in STUD and DIG_INFRA
O (Opportunities)	Inclusive internationalization (INT_STUD), simulation centers and clinical-technology parks; targeted PhD training; EdTech for tutoring and telemedicine	INT_STUD $+0.100^{*}$; synergy of QUAL $\times$ SERV_SUPP; international SDOH agenda [6; 8; 11]
T (Threats)	Substitution of hands-on practice by pure online learning; external shocks (COVID), rising youth unemployment and stress	COVID -2.200^{**} ; UNEMP -0.400^{*} ; risk of reduced practical training under poorly managed digitalization

Comment. The “S” and “O” vectors are directly translatable into programmatic measures within the framework of current national strategies (S. C. o. S. o. t. R. o. Uzbekistan (2025), while the careful balance requires a careful balance between online and offline learning modes, as well as proactive stress prevention. To align theory with policy and governance practice, we propose a sequential roadmap outlining policy measures and their expected effects on the Societal Health Index (SHI), calculated based on the empirical coefficients from Table 7.

Table 8. Action Program for Improving the Societal Health Index (SHI) through Medical Education (Bukhara Region)

Direction	Core Measure	Implementation Mechanism	Expected Effect on SHI
Mentorship and Faculty Development	Reduce student–faculty ratio (target: $\leq 14:1$); expand share of PhD/DSc faculty	Government-funded academic mobility, postgraduate scholarships, faculty development centers	$+3.0$ – 4.5 points (due to improved mentoring and quality of knowledge transfer)
Clinical Practice and Experiential Learning	Increase clinical training hours by 25–30%; establish simulation and skills centers	Joint programs with regional hospitals and digital clinical parks	$+2.0$ – 3.0 points (reinforced preventive skills, better adherence to healthy behaviour)

Student Support Infrastructure	Expand dormitory capacity (≥ 35 beds per 100 students); create integrated support centers (psychological, tutoring, career)	PPP-based campus expansion; integration with municipal housing programs	+2.5–3.5 points (reduced inequality and stress levels)
Digital and Educational Environment	Upgrade LMS and telemedicine modules; implement balanced hybrid learning standards	Digital audit, VR/AR modules for anatomy and diagnostics, IoT-enabled classrooms	+2.0–2.8 points (enhanced access without substitution of practice)
Health Protection and Inclusion	Universal health insurance coverage for students; inclusion of foreign students in wellness programs	Regional health insurance scheme, agreements with private insurers	+1.5–2.0 points (reduction in inequality, improved preventive coverage)
Stress Prevention and Well-being	Regular screening for anxiety and burnout; “Healthy Campus” initiatives	Integration into university QA systems, peer-support networks, mindfulness sessions	+1.0–1.5 points (improved mental health and resilience)

The proposed policy levers can be correlated with the labor market requirements for hard and soft skills in medicine, including clinical competence, evidence-based practice, communication, empathy, and self-regulation.

Table 9. Competency Matrix: Linking Hard/Soft Skills to Model Factors

Skill	Educational Lever	Change Metric	Association with SHI
Hard: Clinical reasoning and procedures	CLIN_HRS (Clinical hours)	+50 hours/year	+2.8 points
Hard: Evidence-based medicine and research	FAC_QUAL (Faculty qualification: % PhD + DSc)	+10 percentage points	+1.7 points
Soft: Mentorship and communication	STU_FAC_RATIO (Students per faculty member)	–2 units	+1.2 points
Soft: Stress resilience and self-regulation	SUP_SERV (Support services index)	+0.3 index points	+1.7 points
Soft: Intercultural competence and inclusion	INT_STUD (Share of international students)	+5 percentage points	+0.5 points
Social determinants (equitable access)	DORM_CAP, INS_COV (Dormitory capacity; health insurance coverage)	+10 dormitory places; +10 p.p. coverage	+0.9; +1.1 points
Digital literacy and simulation	DIG_INFRA (Digital infrastructure index)	+0.3	+0.9 points

Thus, the controllable parameters of the educational environment — mentorship and faculty qualification, clinical practice, support services, housing, insurance, and digital infrastructure — provide statistically and substantively significant increases in the Societal Health Index (SHI). These measures are consistent with both regional and national policy priorities, from the goals of “Uzbekistan – 2030” to higher education and healthcare reforms (Mirziyoyev, 2018; Oybekovna, 2024). Aligning with Avicenna’s classical ethics of moderation and justice (A. A. I. Sina, 2000; Siraisi, 2014).

5. Conclusion

5.1 Conclusion

An operational model of societal health has been proposed for the medical education system of the Bukhara region, integrating health knowledge and skills, preventive behavior, mental well-being, and equitable access, in line with Avicenna's postulates and the WHO framework on social determinants of health. The econometric analysis (OLS, 2020–2024; $n = 48$) demonstrated that reductions in STU_FAC_RATIO, increases in the proportion of qualified faculty (FAC_QUAL), expansion of clinical hours (CLIN_HRS), development of support services (SUP_SERV), dormitory capacity (DORM_CAP), insurance coverage (INS_COV), and digital infrastructure (DIG_INFRA) were statistically associated with higher SHI values. A roadmap of prioritized interventions is recommended, with estimated SHI increments (see Table 9), compatible with national strategies (“Strategy 2022–2026,” “Uzbekistan – 2030”) and regulatory frameworks in higher education and healthcare.

Practical implication: To combine the strengthening of hard competencies (clinical reasoning, evidence-based medicine) through CLIN_HRS and FAC_QUAL with the enhancement of soft competencies (empathy, self-regulation, intercultural communication) via STU_FAC_RATIO, SUP_SERV, INT_STUD, and guided digitalization (DIG_INFRA). Limitations: short time series; partial aggregation of institutional indicators; possible non-linearities in cost and digital effects. Future directions: extension of the panel to the municipal level, quasi-experimental evaluations, and independent validation of the SHI index. In our view, integrating Avicenna's classical principles of measure, mentorship, and harmony with evidence-based approaches to social epidemiology and quality management in medical education represents a productive pathway to improving the societal health of the region under the conditions of digital transformation.

5.2 Suggestion

1. Improving Faculty Quality and Mentorship
Enhancing lecturer qualifications and mentorship culture through continuous training and peer collaboration, reviving Avicenna's *ustoz–shogird* tradition to strengthen competence and ethics.
2. Expanded Clinical Practice:
Increasing clinical hours and community-based training can improve students' practical skills, empathy, and ethical reasoning.
3. Strengthening Student Support Systems:
Improving student–faculty ratios, dormitory capacity, and counseling services to promote well-being and equitable access to education.
4. Promoting Ethical Digitalization:
Digital infrastructure should be developed responsibly, ensuring that technology supports—not replaces—human mentorship and learning interaction.
5. Integrating Soft and Hard Skills:
Balancing clinical competence with empathy, communication, and self-regulation to align education with holistic health goals.
6. Encouraging Family and Community Engagement
Involve families, mentors, and communities in preventive health education to promote collective responsibility for societal well-being.
7. Align with National Policy and Research
Adopt the Societal Health Index (SHI) for monitoring, align programs with *Strategy 2022–2026* and *Uzbekistan2030*, and expand research to municipal levels.
8. Reinforcing Ethical Foundations:
Embed Avicenna's principles of moderation, mentorship, and harmony in medical education cultivate socially responsible and compassionate profession.

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