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Socioeconomic and Migration-Related Determinants of Newborn Metabolic Screening Uptake: A Case–Control Study in Urban Iran

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Abstract

Background:

Newborn bloodspot screening (NBS) is a critical public health intervention for the early detection of inherited metabolic disorders (IMDs). Despite high national coverage in Iran, substantial socioeconomic and migration-related disparities in NBS uptake persist in urban settings. This study aimed to identify socioeconomic, migration-related, and healthcare access determinants associated with reduced NBS uptake among parents in Tehran.

Methods:

A case–control study was conducted among 402 parents attending public health centers affiliated with Tehran University of Medical Sciences between January and November 2025. Cases (n = 108) were parents who refused or did not complete NBS, and controls (n = 294) were parents who completed screening. Data were collected using a validated questionnaire and analyzed using univariate and multivariable logistic regression. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated, with ORs interpreted in relation to NBS uptake.

Results:

Overall, 26.9% of parents did not complete NBS. In multivariable analyses, NBS uptake was significantly lower among non-Iranian families, households in lower wealth quartiles, and those lacking supplemental health insurance. Additional factors associated with reduced uptake included younger maternal age, larger family size, limited healthcare access, and lower perceived importance of NBS ($p < 0.05$). Higher perceived importance of screening and physician-delivered prenatal education were strongly associated with greater NBS uptake.

Conclusion:

Reduced uptake of newborn metabolic screening in Tehran is driven primarily by economic vulnerability and structural barriers faced by migrant families. Equity-oriented interventions—including multilingual counseling, full cost waivers, integration of NBS education into prenatal care, and simplified registration pathways for migrant newborns—are essential to improve participation and strengthen the effectiveness of national screening programs.

1. Background

Newborn bloodspot screening (NBS) is a critical public health strategy for early detection of inherited metabolic disorders (IMDs). Global estimates indicate IMD birth prevalence of 50–75 per 100,000 live births, with the Eastern Mediterranean region reporting the highest rates due to increased parental consanguinity. Mortality from untreated IMDs remains disproportionately high in low- and middle-income countries (LMICs), accounting for nearly 0.4% of global childhood mortality [1].

Since its initial implementation in the 1960s, NBS has achieved near-universal coverage in many high-income countries [2]. However, LMICs continue to face substantial challenges related to financing, health literacy, and infrastructure[3, 4]. In Iran, the national NBS program—launched in 2007—achieves 85–90% coverage, screening for six core disorders and, in select provinces, up to 32 conditions [5, 6]. Despite achieving approximately 85–90% national coverage—and over 96% in regions such as southeast Iran—significant regional disparities persist [5, 7]. Refusal and non-completion rates remain particularly high in urban areas characterized by socioeconomic and cultural diversity[8].

Tehran's diverse population amplifies vulnerabilities, as non-citizens report lower trust in public systems and reduced perceived importance of screening. Similar patterns have been observed in NBS programs across the MENA (Middle East North Africa) region, where logistical, cultural, and financial barriers hinder family acceptance [9]. In Iran, the absence of supplemental insurance highlights structural gaps, particularly for non-Iranian nationals who often lack coverage. These challenges—along with rental housing instability and limited internet access—are further amplified by Tehran’s growing urban migrant population [10].

Previous studies in Iran and other LMICs have identified cost, limited insurance coverage, low parental awareness, cultural beliefs, and mistrust in the healthcare system as major barriers to screening participation [11, 12]. Nevertheless, few studies have systematically compared uptaking and non-uptaking parents using a case-control design in a large academic health network [13].

The present study was conducted in public primary healthcare centers operated under the Health Deputy of Tehran University of Medical Sciences (TUMS), located in southern Tehran and the adjacent cities of Eslamshahr and Rey. These centers primarily serve lower- to middle-income families and a high proportion of migrant populations. Therefore, this case-control study aimed to identify and compare the socioeconomic, migration-related, and attitudinal profiles of parents who refuse NBS versus those who comply, within this diverse urban setting.

By identifying these determinants, we aim to propose targeted, evidence-based strategies to improve NBS uptake and support Iran’s goal of achieving near-universal screening coverage. Strengthening equity within the national NBS framework is particularly crucial for high-risk groups such as migrants and low-income families, especially amid rising IMD prevalence linked to consanguinity [14, 15].

2. Materials and Methods

2.1 Study Design

This was an analytical case–control study aimed at identifying socioeconomic, migration-related, cultural, and healthcare access factors associated with parental refusal or non-completion of newborn blood spot screening in health centers affiliated with Tehran University of Medical Sciences (TUMS). The study protocol was approved by the TUMS Ethics Committee (IR.TUMS.CHMC.REC.1404.046). All procedures were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Participation was voluntary, and written informed consent was obtained from all parents. All data were anonymized prior to analysis.

2.2 Study Population and Setting

The study population included parents of newborns who visited comprehensive health centers under TUMS supervision between January 1 and October 25, 2025. These centers serve predominantly low- to middle-income families in southern Tehran, Eslamshahr, and Rey, districts with substantial migrant populations.

2.3 Sampling and Sample Size

A minimum required sample size of 384 participants was estimated, and 402 parents were ultimately enrolled. Participants were divided into two groups based on screening uptake. The case group consisted of parents who refused NBS or did not complete screening within the recommended timeframe (n = 108), and the control group included parents who consented and completed screening (n = 294).

Non-uptake was defined as either documented refusal of NBS or failure to present the newborn for sample collection within the national time window.

Inclusion criteria

parents of newborns delivered in 2025, residence in areas under TUMS jurisdiction, and willingness to participate.

Exclusion criteria

incomplete questionnaires, withdrawal of consent, relocation, severe newborn medical conditions potentially influencing parental decision-making, neonatal death.

2.4 Data Collection Instrument

Data were collected using a researcher-developed, validated 50-item questionnaire assessing demographic characteristics (age, education, occupation, family size, nationality, income, housing, insurance status), cultural factors (beliefs, awareness, trust in healthcare), and economic barriers (cost and access). The questionnaire was originally developed in Persian for this study and subsequently translated into English for publication purposes. The English version of the questionnaire is provided as Supplementary File 1.

A wealth index was constructed using principal component analysis (PCA) of household assets. Content validity was evaluated by 10 experts (CVR = 0.85, CVI = 0.92), and internal reliability was acceptable (Cronbach's α = 0.87).

Data were collected online via a secure link distributed by trained healthcare workers.

2.5 Data Collection Procedures

Eligible parents were identified by trained staff in participating health centers. After obtaining informed consent, participants completed the questionnaire either independently or with assistance. All data were stored on a secure server accessible only to authorized research personnel.

2.6 Statistical Analysis

Data were analyzed using Stata version 17 (StataCorp, College Station, TX). Continuous variables were reported as means ± SD, and categorical variables as frequencies and percentages.

Group differences were assessed using t-tests for continuous variables and χ^2 or Fisher's exact tests for categorical variables. Screening uptake status (completed vs. non-completed) was determined using health center records, while socioeconomic and attitudinal determinants were assessed using the questionnaire.

Logistic regression analyses were conducted to examine factors associated with completion of newborn metabolic screening (NBS uptake). Odds ratios (ORs) and 95% confidence intervals (CIs) are reported. In all analyses, ORs < 1 indicate lower odds of NBS uptake (i.e., barriers to participation), while ORs > 1 indicate higher odds of uptake.

Assumptions, including multicollinearity, were assessed using variance inflation factor (VIF) thresholds.

3. Results

A total of 402 parents participated in the study. Of these, 294 parents (73.1%) completed newborn blood spot screening (the control group), while 108 parents (26.9%) refused or did not complete screening (the case group). Missing data were minimal (< 5% across variables) and handled using complete-case analysis.

3.1 Demographic and Socioeconomic Characteristics

Non-uptake parents differed significantly from uptaking parents across multiple demographic and socioeconomic indicators. Mothers in the non-uptake parents group were younger (29.0 ± 7.0 vs. 30.5 ± 6.1 years, $p = 0.040$). Family size was larger among non-uptake parents households (4.3 ± 1.2 vs. 3.8 ± 1.0, $p < 0.001$). Parental education was lower (maternal university education: 16.7% vs. 34.4%, $p < 0.001$). Non-Iranian nationality was significantly more common among non-uptake families (51.9% vs. 17.0%, $p < 0.001$). Lack of supplemental insurance (35.4% vs. 9.3%, $p < 0.001$) and lower household wealth status were strongly associated with NBS non-uptake. Access to home internet and digital devices was significantly lower among non-uptake families ($p < 0.01$). Table 1 summarizes key demographic characteristics.

Table 1
Selected sociodemographic and socioeconomic characteristics of parents by newborn blood spot screening uptake status (N = 402).

Characteristic	Non-uptake (n = 108) n (%) or mean ± SD	Uptake (n = 294) n (%) or mean ± SD	p-value
Maternal age (years), mean ± SD	29.0 ± 7.0	30.5 ± 6.1	0.040
Paternal age (years), mean ± SD	35.0 ± 5.5	34.3 ± 6.9	0.844
Non-Iranian nationality	56 (51.9)	50 (17.0)	< 0.001
Maternal education: University level	18 (16.7)	101 (34.4)	< 0.001
Paternal education: University level	17 (15.7)	113 (38.4)	< 0.001
Maternal employment status: Currently employed	6 (5.6)	37 (12.6)	0.022
Number of children ≥ 3	35 (32.4)	76 (25.9)	0.001
Lowest two wealth quintiles (poorest 40%)[a]	72 (66.7)	134 (45.6)	< 0.001
Highest wealth quintile (wealthiest 20%)[a]	4 (3.7)	42 (14.3)	< 0.001
Supplemental health insurance: Has coverage	10 (9.3)	104 (35.4)	< 0.001
Residence ownership: Rented accommodation	80 (74.1)	185 (62.9)	< 0.001
Household has internet access at home	95 (88.0)	287 (97.6)	0.002
Household owns a laptop	63 (58.3)	224 (76.2)	0.001

[a] Wealth index constructed using principal component analysis of household assets.

p-values are based on independent t-tests for continuous variables and χ^2 or Fisher's exact tests for categorical variables.

3.2 Cultural and Awareness Factors

In univariate logistic regression analyses, several access- and perception-related factors were significantly associated with NBS uptake. Parents reporting high perceived cost barriers had lower odds of screening uptake (OR = 5.18, 95% CI: 2.24–11.95). Similarly, lower trust in the public healthcare system (OR = 2.66, 95% CI: 1.12–6.32) and longer travel time to the screening center (> 30 minutes; OR = 2.49, p = 0.016) were associated with reduced uptake. Lack of supplemental insurance was also

associated with lower odds of NBS uptake (OR = 3.78, p < 0.001). In contrast, higher perceived importance of NBS was strongly associated with increased screening uptake (OR = 0.03, 95% CI: 0.01–0.08, p < 0.001). Use of a personal vehicle was associated with higher uptake, indicating that easier physical access facilitates participation (OR < 1). Key univariate associations are presented in Table 2.

Table 2
Selected univariate logistic regression results for factors associated with NBS uptake.

Factor	OR (95% CI)	p-value
High perceived cost barriers	5.18 (2.24–11.95)	< 0.001
Low trust in public healthcare	2.66 (1.12–6.32)	0.027
Travel time > 30 minutes	2.49 (1.18–5.24)	0.016
Use of personal vehicle	0.29 (0.16–0.51)	< 0.001
High perceived importance of NBS	0.03 (0.01–0.08)	< 0.001
No supplemental insurance	3.78 (2.12–6.75)	< 0.001
Note: Odds ratios are presented for NBS uptake. ORs < 1 indicate reduced odds of uptake.		

3.3 Multivariable Logistic Regression

In multivariable logistic regression analysis adjusting for maternal age, parental education, family size, and household income, NBS uptake remained significantly lower among non-Iranian families, households in lower wealth quartiles, and those lacking supplemental health insurance (Table 3). The final model demonstrated good fit (LR $\chi^2 = 68.74$, $p < 0.001$) and explained approximately 15% of the variance in screening uptake (Pseudo $R^2 = 0.147$).

Table 3
Multivariable logistic regression: independent predictors of NBS non-uptake.

Predictor	OR	95% CI	p-value
Non-Iranian nationality	0.22	0.09–0.53	0.001
Wealth quartile (4th vs. 1st)	0.15	0.06–0.33	< 0.001
Lack of supplemental insurance	0.29	0.16–0.54	< 0.001

Odds ratios are presented for NBS uptake. ORs < 1 indicate factors associated with lower uptake.

4. Discussion

This case–control study conducted among 402 parents within the Health Deputy network of Tehran University of Medical Sciences in 2025 revealed that approximately 27% of families either refused or failed to complete newborn blood spot screening (NBS). Overall, NBS uptake was substantially lower

among socioeconomically vulnerable and migrant populations, highlighting persistent inequities in access to preventive child health services in urban Tehran.

In multivariable analyses, NBS uptake was significantly lower among non-Iranian families, households in lower wealth quartiles, and those lacking supplemental health insurance. Together, these findings underscore the combined influence of economic insecurity and structural exclusion on parental participation in newborn screening programs.

Non-Iranian nationality was inversely associated with NBS uptake, a finding that is consistent with several recent reports on migrant health access in Iran. A 2023 SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis of the Iranian health system's response to Afghan refugees highlighted systemic barriers such as limited insurance coverage and legal constraints that restrict migrants' utilization of preventive services, including NBS [16]. A 2024 ethico-legal review further identified fear of deportation and language barriers, as key reasons Afghan families avoid maternal and child health services, including newborn screening [17]. Similar patterns have been documented regionally among Afghan returnees[18], and internationally in migrant NBS gaps in MENA programs where logistical, cultural, and financial barriers hinder family acceptance [10]. These factors likely mediate the observed association between migration status and lower screening uptake, potentially through reduced trust in public institutions and constrained access to insurance and healthcare information [19].

Economic vulnerability emerged as a second dominant determinant of reduced NBS uptake. Families without supplemental health insurance and those in lower wealth quartiles consistently demonstrated lower participation in screening. These findings align with a 2021 policy analysis of Iran's national phenylketonuria screening program, which identified incomplete insurance coverage and out-of-pocket expenses as major obstacles to achieving universal screening uptake [11]. More recent evidence from expanded metabolic screening initiatives in Iran further confirms that socioeconomic disparities remain a key driver of non-completion, despite national program expansion [5]. Even when core NBS services are publicly funded, anticipated downstream costs—such as confirmatory testing or long-term treatment—may discourage participation among economically disadvantaged families, a pattern also observed in other low- and middle-income settings [20] [21].

Lower parental education was strongly associated with non-uptake in unadjusted analyses but did not remain an independent predictor after controlling for wealth and nationality. This attenuation suggests that the effect of education on screening participation is largely mediated through economic status and access to resources rather than acting as an independent determinant, a pattern consistent with previous newborn screening refusal studies [13, 14]. Similarly, cultural mistrust and healthcare skepticism were significant in univariate analyses but lost statistical significance in multivariable models, indicating that in urban Tehran these attitudes may operate primarily through structural and economic pathways rather than as isolated barriers [8].

Notably, perceived importance of NBS emerged as the strongest facilitator of screening uptake in the entire study. Parents who reported higher perceived importance of screening were substantially more likely to complete NBS, independent of general awareness levels. This finding highlights a critical distinction between simple knowledge of screening and deeper conceptual understanding of its preventive value. Parents with limited health literacy may be aware of NBS but fail to appreciate its long-term benefits, leading to hesitation or refusal. Prior studies have similarly shown that misconceptions regarding screening accuracy, potential harm, or stigma can substantially reduce parental acceptance [22, 23].

The source of prenatal education also appeared to be critical. Information delivered by physicians was significantly associated with higher NBS uptake, whereas information obtained through social media, family members, or peers showed no measurable effect. This underscores the importance of trusted, professional communication in shaping parental decision-making and supports the integration of structured, physician-led counseling into routine antenatal care.

Families with larger household sizes and younger mothers were also less likely to complete screening. Larger families may face competing financial and caregiving demands that deprioritize preventive services Younger maternal age has been associated with lower utilization of maternal and newborn health services in low- and lower-middle-income settings, potentially reflecting limited experience, reduced autonomy, and demand-side access barriers. Similar associations between maternal age, family size, and reduced utilization of maternal and child health services have been reported elsewhere [24, 25].

Compared with high-income countries, the NBS non-uptake rate observed in this study (approximately 27%) is markedly higher than European benchmarks (0.1–3%) but comparable to rates reported in other middle-income settings with partial cost-sharing, such as the Philippines and Brazil [3, 26, 27]. Similar challenges have also been reported across the Eastern Mediterranean Region, highlighting persistent equity gaps in newborn screening programs [28]. These international comparisons suggest that Iran's national screening coverage—while commendable—conceals substantial urban and socioeconomic disparities, particularly in migrant-dense areas such as southern Tehran. Similar inequities have been documented across the MENA region, emphasizing that technical expansion of screening panels alone is insufficient without parallel equity-focused policy interventions [10].

This is one of the first Iranian studies to use an analytical case–control design with multivariable adjustment within a large urban academic health network [5]. However, several limitations should be acknowledged. The study was confined to public health centers affiliated with Tehran University of Medical Sciences in southern Tehran, Eslamshahr, and Rey, limiting generalizability to wealthier districts, private healthcare facilities, or regions served by other medical universities. Additionally, the case–control design precludes causal inference, and unmeasured factors—such as duration of migration or specific cultural beliefs—may have influenced parental decisions.

5. Conclusion

In conclusion, reduced NBS uptake in Tehran is driven primarily by economic insecurity and structural exclusion of migrant families. Achieving near-universal screening coverage will require targeted equity-oriented strategies, including full cost waivers, multilingual counseling, integration of NBS education into prenatal care, and simplified administrative pathways for migrant newborns. Without addressing these structural barriers, further technical expansion of screening programs is unlikely to close the participation gap between vulnerable urban populations and high-income settings [2, 4].

Abbreviations

IMD	Inherited Metabolic Disorder
LMIC	Low- and Middle-Income Country
MENA	Middle East and North Africa
NBS	Newborn Bloodspot Screening
OR	Odds Ratio
PCA	Principal Component Analysis
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
SWOT	Strengths, Weaknesses, Opportunities, Threats
VIF	Variance Inflation Factor

Declarations

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Author Contribution

S.A.: Conceptualization, Methodology, Investigation, Supervision, Writing – Review & Editing, Project administration. F.A.: Conceptualization, Writing – Review & Editing, Project administration. M.H.: Methodology, Validation, Formal analysis, Investigation, Resources. F.S.: Methodology, Validation, Formal analysis. R.Moh.: Writing – Review & Editing, Project administration. R.Mor.: Data curation, Writing – Original draft. H.I.: Software, Investigation. A.K.: Investigation, Resources, Writing – Review & Editing. All authors reviewed and approved the final manuscript.

Data Availability

The datasets generated and/or analysed during the current study are not publicly available due to privacy restrictions and Iranian regulations on health data but are available from the corresponding author on reasonable request and with permission of the Ethics Committee of Tehran University of Medical Sciences.

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