Internal migration seeking medical care for prostate cancer

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Hernández-Pérez JG, Reyes-Morales H, Lajous M, Arenas P, Rodríguez-Covarrubias D, Manzanilla-García H, Mohar A, Torres-Sánchez L. Internal migration seeking medical care for prostate cancer. Salud Publica Mex. 2025;67:39-47.
https://doi.org/10.21149/16102

Abstract

Objective. To characterize the migratory flow of Mexican men affiliated to *Seguro Popular* (SP) seeking medical care for prostate cancer (PC). **Materials and methods.** The administrative base for the treatment of incident CP (5 526 men) funded by the SP (2012-2016) was used. Oncological risk at diagnosis (low, intermediate, high) was estimated based on prostate-specific antigen, Gleason score, and clinical stage. Spatial network analysis and centrality measures were used to identify the health migratory flow. **Results.** 1 369 men sought treatment outside their state of residence, all of them with a diagnosis of PC (25%), mainly <65 years of age, high-risk PC, and residents of highly marginalized municipalities. Throughout the study period, Mexico City (closeness-in= 0.34) received the largest number of patients (importance-in= 1 082) from 26 different states (degree-in= 26). This flow was more evident in patients with a high-risk PC, mainly towards hospitals with a high degree of specialization in cancer. **Conclusions.** A centralized migration (with two potential migration patterns) in search of treatment for PC was observed, mainly in men with high-risk PC.

Keywords: internal migration; medical care; Mexico; prostate cancer; spatial network analysis

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https://doi.org/10.21149/16102

Resumen

Objetivo. Caracterizar el flujo migratorio de hombres mexicanos afiliados al Seguro Popular (SP) que recibieron atención médica para el cáncer de próstata (CP). **Material y métodos.** Se utilizó la base administrativa para el tratamiento del CP incidente (5 526 hombres) financiada por el SP (2012-2016). El riesgo oncológico al diagnóstico (bajo, intermedio y alto) se estimó con base en el antígeno prostático específico, escala de Gleason y la etapa clínica. El flujo migratorio se identificó con un análisis de redes espaciales y medidas de centralidad. **Resultados.** 1 369 hombres buscaron tratamiento fuera de su estado de residencia, todos ellos con diagnóstico de CP (25%), principalmente <65 años, CP de alto riesgo y residentes en municipios altamente marginados. A lo largo del periodo de estudio, la Ciudad de México (*closeness-in*= 0.34) recibió el mayor número de pacientes (*importance-in*= 1 082) provenientes de 26 estados diferentes (*degree-in*= 26). Este flujo fue más evidente en los pacientes con un CP de alto riesgo, principalmente hacia los hospitales con alto grado de especialización en cáncer. **Conclusión.** Se observó una migración centralizada (con dos potenciales patrones de migración) en búsqueda de tratamiento para el CP, principalmente en hombres con CP de alto riesgo.

Palabras clave: migración interna; atención médica; Mexico; cáncer de próstata; análisis de redes espaciales

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Received on: June 6, 2024 • **Accepted on:** August 8, 2024 • **Published online:** November 27, 2024
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Cancer is a complex disease, and access to health services is crucial to its management. However, health disparities and inequities in cancer care, common across racial, ethnic, and socioeconomic groups,[1] impulse a health migration process mainly among those with more severe cancer.[2] Health migration is a short-term migratory flow, followed by the return to the region of origin after the intervention period.[3] The decision to migrate and the selected destination are mainly determined by the expectation of better health services at a reduced cost and the support of relatives or friends.[3]

There is evidence regarding health migration flow when seeking for health care,[3-5] specifically cancer care, from European countries,[2,6,7] the United States[8] and the US-Mexico border.[9] Overall, findings suggest a centralized health migration flow toward economically advantaged regions, which is determined by the severity of the disease, perception of cheaper and better healthcare service, and the existence of family support in the destination that reduces the costs of migration. Studies focused on prostate cancer (PC) indicate that the availability of innovative technology, such as robotic surgery, is a relevant determinant of health migration.[6,7] Regardless of the reasons for migration, traveling for medical care has been associated with physical and emotional symptoms, poor symptom control, and treatment discontinuation, all of which contribute to worse survival outcomes for cancer patients.[10-13]

In Mexico, PC is the main cause of cancer (39.1/100 000 hab) and cancer death (9.7/100 000 hab) among men over 60 years old.[14,15] A high oncological PC risk at diagnosis and a very high marginalization are the main determinants of poor PC survival.[16] Nevertheless, a previous PC survival analysis performed among males affiliated to *Seguro Popular* (SP) showed a lower risk of PC death for those who received medical care at their residence state, regardless of their oncological risk.[16] SP was a public healthcare system created for the most vulnerable population to reduce health inequities.[17] Until its elimination in 2019, SP covered several types of cancer, including PC. Medical care was provided by accredited public hospitals, which demonstrated their technical capacity for cancer treatment. PC care was incorporated into SP in 2012, with 13 accredited hospitals located in 10 federal entities. This number gradually increased, reaching 29 accredited hospitals in 23 states. Most states had one accredited hospital in the state capital, while the capital of Mexico (Mexico City) had four, and the states with the largest populations (Jalisco, State of Mexico, and Veracruz) each had two accredited centers.

Identifying the health migration flow characteristics could be an initial useful step for planning actions to limit this mobilization and mitigate its consequences. For this reason, we identified and characterized the health migration flow among vulnerable Mexican men affiliated to SP who seek medical care for PC using a spatial network analysis.

Materials and methods

A cross-sectional analysis was carried out. The study included information about males aged between 40 and 95 years with a first diagnosis of PC who received treatment between 2012 to 2016 in any of the hospitals accredited by SP. The administrative register information was obtained through a collaborative agreement with Mexico's National Commission for Social Protection in Health. This project was approved (Project ID: 1 695) by the Review Board of the National Institute of Public Health of Mexico (INSP, by its acronym in Spanish).

For all participants, we had the following information: the Mexican Population Registry Number (CURP, by its acronym in Spanish), age, state and municipality of residence, date of diagnosis, oncological risk at diagnosis, and hospital and state where medical care was received. The revision and filtering of the database was performed independently by state of residence and year. Initially, the database structure involved a row for each date of consultation (diagnostic or treatment) for every individual. Once filtered, data corresponding to each state was merged and then transformed into a format in which each row represents an individual and the columns correspond to the consultation date. Finally, the databases of different states were combined. Among the 5 563 identified cases, 33 subjects were excluded due to the lack of oncological risk at diagnosis (n= 5 530) or because the diagnosis date was before January 1st, 2012. In addition, four CURP were registered in two different states. For these, the record corresponding only to diagnosis was eliminated. Health migration was considered as such when the participant indicated a residence different than the state where PC treatment was received. The final sample size was 5 526 new PC cases.

The oncological risk at diagnosis was estimated based on the serum concentration of prostate-specific antigen (PSA), Gleason score, and clinical stage of the tumor, as follows: low-risk (PSA <10 ng/mL, Gleason <6, clinical stage T1 or T2a), intermediate-risk (PSA= 10-20 ng/mL, Gleason= 7, or T2b), and high-risk (PSA >20 ng/mL, Gleason= 8-10, or ≥T2c).[18] Based on the national marginalization index that considers four dimensions (education, housing, monetary income, and access to facilities providing health and communication services influenced by geographic location), we classified the state and municipality of residence into five categories: very low, low, intermediate, high, and very high marginalization.[19]

Statistical analysis

To characterize the study population, we estimated the proportion of males who received treatment outside their state of residence according to the year of SP, age group, oncological risk at diagnosis, and the state and municipality marginalization.

Spatial network analysis

To characterize the health migratory flow for PC medical care, we used a spatial network analysis. This approach considers the number of PC patients who migrated from their residence state to receive medical care. First, we used geostatistical information to create the shape of Mexico. Then, we created an I-graph object to identify the patients' migration flow between states. Finally, we combined all the steps above into a single function to represent the network structure on a map depicting Mexico. Each node and narrow on the Mexico map respectively represent the states and flow direction.

Centrality measures (importance, degree, closeness, betweenness, and eigenvector) were also calculated from the I-graph object; this allowed us to identify the importance of each node regarding network structure.[20] Importance denotes the number of PC patients arriving at (in) or departing from (out) a node, while the degree centrality measure captures the number of nodes (states) involved in these arrivals (in) or departures (out). Closeness indicates how closely connected are other nodes in terms of short paths leading to each node (in) or originating from one to another (out). A closeness value near to one denotes that the connections between states are short in terms of geographic distance. Betweenness considers closeness (in and out) to identify nodes that play a crucial role in the connection between nodes (near one: minimal influence; highest value: highly influential). Finally, the eigenvector is a summary measure of centrality; nodes (or states) with an eigenvector value close to one have more connections with other states, indicating either a higher number of patients leaving or arriving at these nodes, or their role as intermediaries in other connections. Formulas for these measures are presented in the supplementary table I.[21] For several states, closeness-out or -in was not calculated due to the absence of patients traveling to or from these states looking for PC care.

On the map, the size of the node represents the importance out, while the color narrow represents the importance in. Migration (yellow) or medical care of the same state (blue) was highlighted by the color node; the legend "not applicable (NA)" on the map corresponds to states that did not have any PC patients within the represented risk group or calendar year. All centrality statistics and graph properties were calculated using only the information from patients who sought care outside their state of residence; the graph does not feature loops.

Since Mexico City had the greatest number of accredited hospitals located in different zones of the city, and with different levels of specialization in cancer care (three general hospitals, and the National Cancer Institute [INCan, by its acronym in Spanish] with the highest specialized cancer care), we performed an additional analysis. Using the Chi2 test, we compared the total proportion of PC patients residing outside Mexico City who received PC treatment in each hospital. In addition, we stratified these proportions by place of residence (State of Mexico and other states), and by oncological PC risk.

Data was analyzed with the statistical software R, version 4.3.0, using the sf, igraph, tidyverse, and ggplot2 packages.

Results

From the 5 526 PC patients affiliated with SP, 1 369 (~25%) sought care for PC outside of their residence state (table I). This health migration proportion varied according to several characteristics. The highest proportion was observed in the first year after the incorporation of PC treatment into the SP system (32.2%), decreasing in successive years. Patients that were 65 years or younger (27.4%) and with high-risk PC (27.0%) at diagnosis were more likely to seek treatment outside their residence state. Residents of very low marginalization states had the lowest out-of-state treatment percentage. However, the proportion of men treated outside their state of residence slightly increased when we considered the marginalization levels of the municipality of residence.

Mexico City and Jalisco were the main receptor states for men seeking medical care for PC (table II and figure 1). Mexico City received 1 082 patients from 26 different states (Importance-in= 1 082; Degree-in= 26). Jalisco received 97 patients from 12 states (Importance-in= 97; Degree-in= 12). The state with the highest number of migrating patients (n= 666) was the State of Mexico (Importance-out= 666), they migrated to six different states (Degree-out= 6). This state was also the most influential (Betweenness= 229.00) state. Nevertheless, Mexico City was the main receptor state (Eigenvector= 1.00). Regarding those states without accredited hospitals, the most relevant migration corresponded to Hidalgo and Michoacan with 103 and 102 patients, respectively. Patients from Michoacan and Zacatecas migrated to a high number of states to receive PC care (Degree-out= 6). The lowest migration flow was observed from Baja California Sur and Nuevo León. No differences were observed according to the SP year (supplementary figures 1 A-C).[21]

Table I

Mexican men affiliated to SP who received prostate cancer treatment out-of-residence state according to selected characteristics. Mexico 2012-2016

Characteristics	n (5 526)	Out-of-residence state treatment	
		n= 1 369	%
Year of SP operation			
2012	382	123	32.2
2013	903	241	26.7
2014	1 165	266	22.8
2015	1 548	349	22.5
2016	1 528	390	25.5
Age at diagnosis (years)			
<65	1 604	439	27.4
65-75	2 477	616	24.9
>75	1 445	314	21.7
Oncological risk group*			
Low	588	90	15.3
Intermediate	1 242	281	22.6
High	3 696	998	27.0
Residence's state‡ marginalization			
Very low	847	9	1.1
Low	2 089	721	34.5
Medium	829	177	21.4
High	1 119	339	30.3
Very high	642	123	19.2
Residence's municipality marginalization			
Very low	2 481	548	22.0
Low	881	255	28.7
Medium	540	166	30.4
High	549	167	30.4
Very high	93	31	33.3
Unspecified	982	208	21.1

* Low-risk (PSA <10 ng/mL, Gleason < 6, tumor clinical stage T1 [cT1] or cT2a), intermediate-risk (PSA= 10-20 ng/mL, Gleason= 7, or cT2b), and high risk (PSA >20 ng/mL, Gleason= 8-10, or ≥cT2c)

‡ Very low: Baja California Norte, Coahuila, Mexico City, Nuevo Leon; Low: Aguascalientes, Baja California Sur, Colima, Chihuahua, Jalisco, State of Mexico, Sonora, Tamaulipas; Medium: Durango, Guanajuato, Morelos, Nayarit, Queretaro, Quintana Roo, Sinaloa, Tlaxcala, Zacatecas; High: Campeche, Hidalgo, Michoacan, Puebla, San Luis Potosi, Tabasco, Veracruz, Yucatan; Very High: Guerrero, Oaxaca, Chiapas

SP: *Seguro Popular*

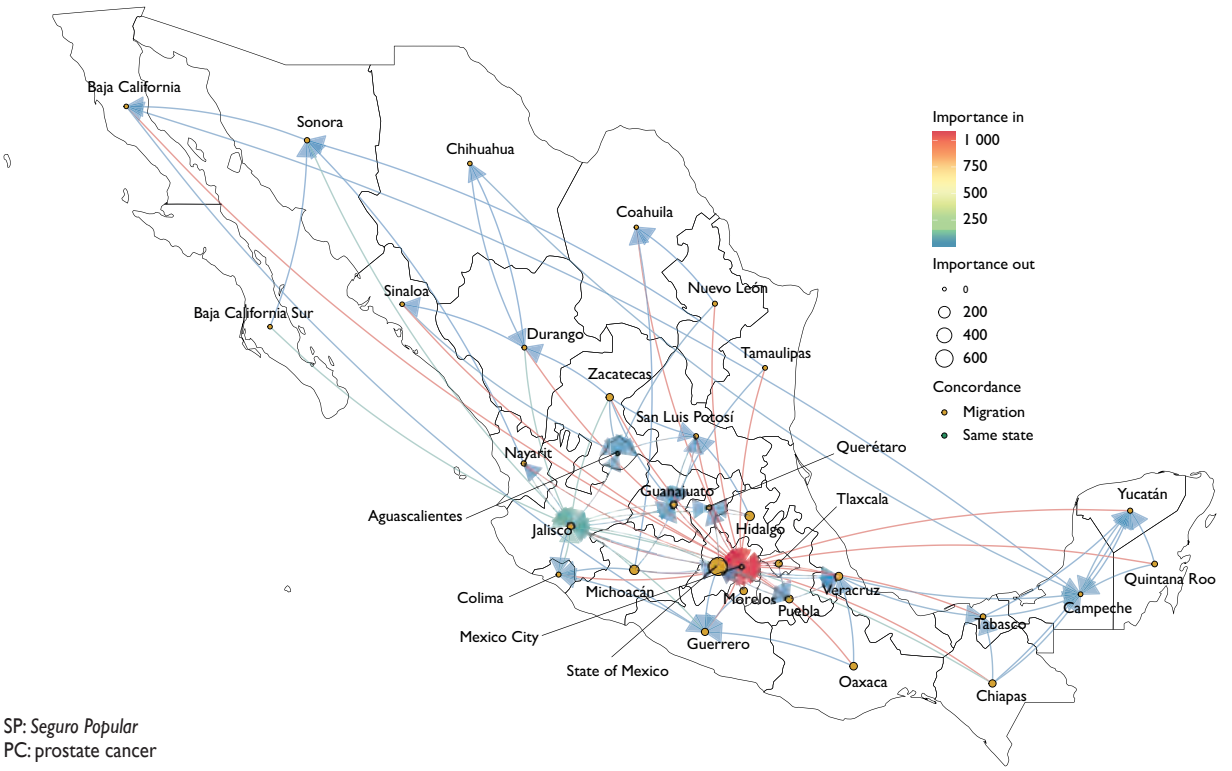
Irrespective of oncological risk at diagnosis (supplementary tables II and III[21] and figures 2 A-C), Mexico City (Importance-in: high-risk PC 806 to low-risk PC 55) and Jalisco (Importance-in: high-risk PC 36 to low-risk PC 26) continued to be the states receiving the highest number of PC patients; however, this was more evident in patients with high-risk PC at the time of diagnosis (table III and figure 2C). For both the high (figure 2C) and intermediate-risk (figure 2B) PC groups, Mexico City was the highest importance state in the migratory flow (Eigenvector= 1.00) since it received the highest number of patients from other states (~12 states), which are not geographically close (Closeness: high-risk= 0.34; intermediate-risk= 0.07).

Mexico City had four accredited tertiary care hospitals, in which around 60% of men who received PC care came from other states (supplementary table IV),[21] mainly from the nearby State of Mexico (35.96%), with some differences by hospitals. According to their location within Mexico City, those in the northern-central area of the city had the highest proportion of patients from the neighboring State of Mexico, with no differences according to oncological risk. Conversely, the most specialized cancer care hospitals located in the southern area of the city had similar proportions of patients coming from the neighboring State of Mexico and other states; as expected, these patients had predominantly a high-risk PC diagnosis. The lowest proportion of patients living outside Mexico City received care in a non-cancer specialized hospital located in the southern area of the city.

Discussion

Our results confirm that migration to Mexico City from other states was high for PC treatment during the study period. This migratory phenomenon was mainly observed among patients with high-risk PC diagnosis and was not determined by geographic proximity.

The magnitude of health migration observed in this study (25%) is difficult to compare to similar studies since they have been conducted in populations and health systems with unique characteristics. However, our findings are consistent with the higher health migration flow observed in patients with malignant male genital cancers,[2,22] and those who migrated seeking specialized medical care independent of distance.[2,4,23] The high health migration flow towards Mexico City, regardless of geographic distance and oncological risk, is a characteristic feature of the centralization of highly specialized health services. Mexico City was the state with the highest (~3.2) average of hospital beds and healthcare workers (~6.5) per 1 000 individuals affiliated with SP[24] and with the most highly specialized hospitals, including the INCan,



SP: *Seguro Popular*
PC: prostate cancer

FIGURE 1. INTERNAL HEALTH MIGRATION FLOW WHEN SEEKING MEDICAL CARE FOR PC AMONG MEXICAN MEN AFFILIATED TO SP. MEXICO, 2012-2016

which receives PC patients from all over the country, particularly high-risk PC patients. These centers have unique features that explain, in part, two potential migratory triggers. The first is associated with geographical proximity, and the second is the wider availability of medical and technological resources, as well as the presence of more experienced healthcare providers.

The lack of specialized resources for the treatment of aggressive PC cases, as well as the patient's expectation of obtaining timely and highly specialized healthcare (medical equipment, technology, novel cancer drugs, and experience concerning disease or severity), might be the main determinants for this internal migration flow.[5,9,25] Nevertheless, it is relevant to highlight that health migration is not devoid of complications. A Mexican cohort study[16] reported that men receiving PC treatment in their home state had a lower risk of dying from PC, regardless of age, marginalization of the residence municipality, and oncological risk at diagnosis. Similar to that observed in previous studies,[10-13] men treated in their place of residence may have a better prognosis, more frequent outpatient contact after diagnosis, and better adherence to treatment.

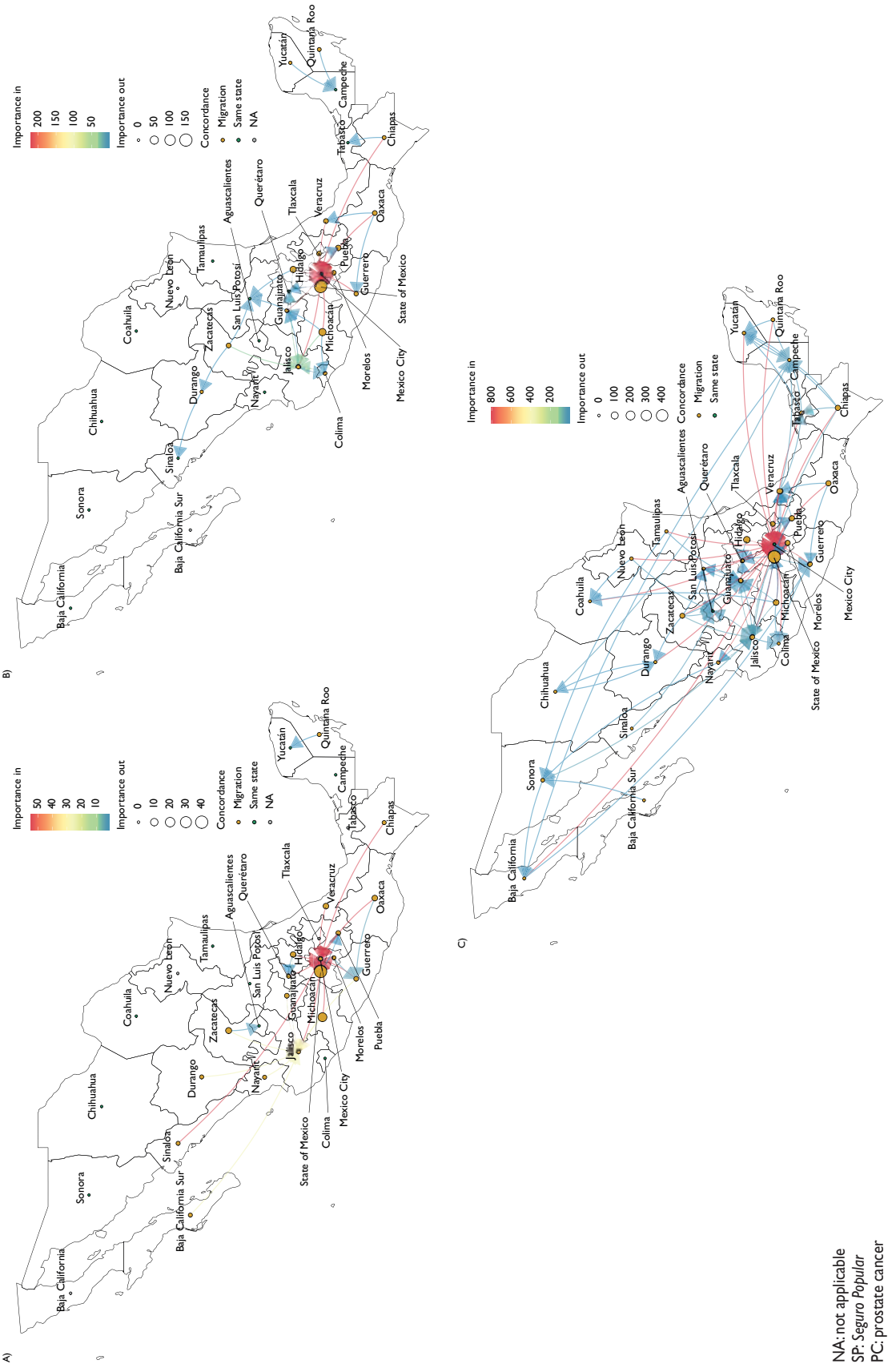
As far as we know, this is the first study with national representativeness assessing migration flows of PC patients looking for specialized medical care. Nonetheless, for a proper interpretation of our results, we must consider certain limitations. These results can only be extrapolated to a specific group of vulnerable men (with no social security and poor access to medical and economic resources). We do not reject the possibility that migration estimations are underestimated; due to fear of not receiving the required health care, some people may have registered as residents in the main receptor hospitals. Likewise, there is the possibility that some patients could have had double affiliations. However, due to the enrolment conditions established by the SP, we would expect it to be a small proportion that would only overestimate the migration flow if the proportion of men with double affiliations was significantly higher among those diagnosed with high-risk PC. The lack of information about socioeconomic conditions at the individual level may have reduced the possibility of observing a clear trend in the migration proportion according to marginalization level. Finally, the use of administrative records precluded the identification of actual causes for migration, time from diagnosis to migration decision, or

Table II

Centrality measures for internal health migration flow when seeking medical care for PC among Mexican men affiliated to SP. Mexico, 2012-2016

Hospitals	SP Year of entry	States	Centrality measures: Importance Out	Importance In	Degree Out	Degree In	Closeness Out*	Closeness In‡	Betweenness	Eigenvector
Accredited	2012	Coahuila	1	2	1	2	0.23	1.00	17.00	0.00
	2016	Sinaloa	2	1	2	1	0.25	0.33	2.00	0.00
	2014	Durango	4	6	4	2	0.37	0.33	15.00	0.00
	2012	Mexico City§	1	1 082	1	26	0.28	0.33	190.50	1.00
	2012	Jalisco#	36	97	6	12	0.30	0.33	186.83	0.01
	2013	Veracruz#	55	9	3	4	0.23	0.31	126.33	0.08
	2013	State of Mexico#	666	4	6	4	0.36	0.29	229.00	0.98
	2015	Chihuahua	2	1	2	1	0.32	0.29	4.00	0.00
	2012	Campeche	3	22	2	6	0.25	0.25	83.33	0.00
	2013	Nayarit	7	1	3	1	0.24	0.25	39.83	0.00
	2013	Puebla	53	7	3	2	0.27	0.23	16.00	0.08
	2012	Guerrero	36	16	3	4	0.30	0.23	59.83	0.05
	2012	Sonora	8	3	2	3	0.24	0.21	13.50	0.00
	2012	Baja California	2	8	2	2	0.28	0.21	54.33	0.00
	2012	Queretaro	7	10	1	3	0.10	0.20	0.00	0.01
	2013	Tabasco	12	22	3	2	0.20	0.20	12.00	0.01
	2013	Colima	4	21	2	3	0.23	0.19	5.83	0.00
	2014	Guanajuato	25	17	4	5	0.19	0.22	56.00	0.02
	2013	Yucatan	6	9	2	4	0.24	0.18	19.00	0.00
	2012	Aguascalientes	0	26	0	5	NA	0.16	0.00	0.00
	2012	San Luis Potosi	5	5	3	3	0.20	0.16	34.00	0.00
	2015	Chiapas	39	0	5	0	0.28	NA	0.00	0.02
	2013	Tamaulipas	3	0	3	0	0.30	NA	0.00	0.00
No accredited	No	Hidalgo	103	0	4	0	0.25	NA	0.00	0.14
	No	Oaxaca	48	0	3	0	0.11	NA	0.00	0.05
	No	Michoacan	102	0	6	0	0.31	NA	0.00	0.04
	No	Quintana Roo	12	0	3	0	0.19	NA	0.00	0.00
	No	Morelos	45	0	3	0	0.30	NA	0.00	0.07
	No	Baja California Sur	2	0	2	0	0.25	NA	0.00	0.00
	No	Zacatecas	42	0	6	0	0.25	NA	0.00	0.00
	No	Tlaxcala	33	0	2	0	0.10	NA	0.00	0.04
	No	Nuevo Leon	5	0	3	0	0.21	NA	0.00	0.00

* Labeled as "not applicable" (NA) when no patients from that state seek medical care in another state
‡ Labeled as NA when this state did not receive any patients from other states seeking medical care
§ States with four accredited hospitals for PC care
# States with two accredited hospitals for PC care
SP: *Seguro Popular*
PC: prostate cancer



NA: not applicable
SP: *Seguro Popular*
PC: prostate cancer

FIGURE 2. INTERNAL HEALTH MIGRATION FLOW WHEN SEEKING MEDICAL CARE FOR PC AMONG MEXICAN MEN AFFILIATED TO SP BY ONCOLOGICAL RISK GROUP A) LOW, B) INTERMEDIATE, AND C) HIGH. MEXICO, 2012-2016

Table III

Centrality measures for internal health migration flow when seeking medical care for high-risk PC among Mexican men affiliated to SP. Mexico, 2012-2016

SP		States	High-risk PC							
			Centrality measures							
			Importance		Degree		Closeness		Betweenness	Eigenvector
Hospitals	Year of entry		Out	In	Out	In	Out*	In‡		
Accredited	2012	Coahuila	1	2	1	2	1.00	1.00	1.50	0.00
	2016	Sinaloa	1	0	1	0	1.00	NA	0.00	0.00
	2014	Durango	2	4	2	2	0.35	0.50	4.33	0.00
	2012	Mexico City§	0	806	0	25	NA	0.34	0.00	1.00
	2012	Jalisco#	30	36	6	7	0.37	0.46	108.17	0.01
	2013	Veracruz#	43	8	3	4	0.39	0.37	72.67	0.09
	2013	State of Mexico#	475	3	5	3	0.41	0.44	53.00	0.97
	2015	Chihuahua	2	1	2	1	0.44	0.40	7.33	0.00
	2012	Campeche	3	18	2	6	0.50	0.30	63.67	0.00
	2013	Nayarit	6	1	3	1	0.23	0.33	10.00	0.00
	2013	Puebla	37	5	3	1	0.30	0.20	16.00	0.07
	2012	Guerrero	29	10	2	3	0.67	0.22	22.00	0.06
	2012	Sonora	8	3	2	3	0.28	0.30	30.50	0.00
	2012	Baja California	2	8	2	2	0.75	0.24	36.00	0.00
	2012	Queretaro	6	7	1	3	0.17	0.22	1.00	0.02
	2013	Tabasco	12	21	3	2	0.21	0.22	7.33	0.01
	2013	Colima	1	17	1	3	1.00	0.19	1.50	0.00
	2014	Guanajuato	20	14	4	5	0.31	0.38	52.17	0.03
	2013	Yucatán	5	8	2	4	0.22	0.21	5.50	0.00
	2012	Aguascalientes	0	24	0	5	NA	0.27	0.00	0.00
	2012	San Luis Potosi	5	2	3	2	0.25	0.30	22.67	0.01
	2015	Chiapas	35	0	5	0	0.33	NA	0.00	0.02
	2013	Tamaulipas	3	0	3	0	0.28	NA	0.00	0.00
No accredited	No	Hidalgo	78	0	2	0	0.20	NA	0.00	0.16
	No	Oaxaca	36	0	3	0	0.16	NA	0.00	0.05
	No	Michoacan	51	0	6	0	0.35	NA	0.00	0.05
	No	Quintana Roo	8	0	3	0	0.26	NA	0.00	0.00
	No	Morelos	38	0	2	0	0.30	NA	0.00	0.08
	No	Baja California Sur	1	0	1	0	0.23	NA	0.00	0.00
	No	Zacatecas	29	0	6	0	0.23	NA	0.00	0.00
	No	Tlaxcala	26	0	2	0	0.12	NA	0.00	0.04
	No	Nuevo Leon	5	0	3	0	0.75	NA	0.00	0.01

* Labeled as "not applicable" (NA) when no patients from that state seek medical care in another state
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how this decision may have affected treatment adherence, as well as wellness, family, and economic issues.

Conclusion

Health migration when seeking PC treatment is centralized and more evident among men with high-risk PC. The reform of the Mexican health system for the population without social security, which eliminated SP, centralized the organization and provision of health services in a newly created agency, IMSS-Bienestar. The challenge is to develop strategies that, together with effective early PC detection programs, could contribute to reducing this migration and its adverse consequences. First, it is necessary to determine the prevalence severity of PC at the time of diagnosis in each state; second, to identify the possible reasons for migration; and finally, to allocate resources based on the two previous aspects.

Declaration of conflict of interests. The authors declare that they have no conflict of interests.

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