

# A Model for Assessing the Gap between Physician Residency Demand and Present Status

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**ABSTRACT:** **Background:** The medical workforce shortage worldwide varies for different residencies.

**Objectives:** To determine future gaps in medical specialties in Israel by means of a model and to identify trends and considerations among medical students when they choose their residencies.

**Methods:** The gap ( $G_i$ ) assessment model was based upon current demand ( $D_i$ ) and existing ( $E_i$ ) status for each residency, using the formula  $[G_i=(D_i-E_i)/E_i]$ .  $E_i$  represented the proportion of specific residencies in 2006–2010 out of all Israeli residency graduates and  $D_i$  was based on questionnaires filled out by medical students at Sackler and Hadassah medical schools in Tel Aviv and Jerusalem, respectively ( $N=909$ ).

**Results:** The largest relative shortages ( $G_i$  ranges from -1 to 1) were in Pathology ( $G=-1$ ), Rehabilitation Medicine (-0.9), Radiology (-0.8), Family Medicine (-0.8) and Anesthesiology (-0.8). The highest relative demands were in Surgical subspecialties (2.9) and Obstetrics/Gynecology (OB/GYN) (1.6). More females than males chose residencies in OB/GYN (19.5% vs. 7.1%,  $P < 0.001$ ) and Pediatrics (28.1% vs. 15.4%,  $P < 0.001$ ). Surgery subspecialties (9% vs. 23.7%,  $P < 0.001$ ) were male-predominant. The workload consideration was rated higher among females, while income was rated higher among males. Among students in clinical years, compared to pre-clinical, there was a decline in the selection of some professions, including Surgical subspecialties (9.7% vs. 19.5%,  $P < 0.001$ ).

**Conclusions:** The suggested model, based on a survey of demand and current or projected future needs, can be used to assess gaps and plan early interventions. Programs at the level of medical school may affect residency preferences. The decline in selection of surgical professions and the increasing workload as a consideration for residency choice should be given attention.

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**KEY WORDS:** gender, residency, students, workforce, physicians

The medical workforce shortage is well known around the world [1-3]. In Israel, it is especially prominent in the residencies that are officially defined as professions “in short-age” – Anesthesiology, Intensive Care, Neonatology, Internal Medicine, Geriatrics, General Surgery, Emergency Medicine, Pathology, Children’s Hemato-Oncology, Rehabilitation Medicine, Child and Adolescent Psychiatry, and Nuclear Medicine [4].

In the work agreements of 2008 and 2011 between the Israel Medical Association, representing physicians, and the employers [4,5], salary increments were given to the above mentioned professions. As of now, the impact of these increments on the medical students’ preferences is still unknown.

The medical profession, once a male-dominated profession, is experiencing feminization. Women constitute 41% of Israel’s physicians; of those receiving medical licenses in 2010, 45% were women compared to only a third in the 1980s [6]. Therefore, it is important to analyze the patterns according to which both genders choose their residency. This analysis will allow future planning of the workforce, presently non-existent in Israel, as already mentioned by a public committee in 2002 [7] and as reported for the Obstetrics and Gynecology (OB/GYN) specialty [8].

Considerations influencing medical students’ residency choices are, among others, financial, social, and exposure to clinical practice [9,10]. The Jefferson Longitudinal Study of Medical Education, which collected data on 4312 students between the years 1976 and 1995, demonstrated gender-based segregation regarding specialty choice, which was generally higher among fourth year than among first year students [11]. The study showed predominantly “male” fields, such as Surgery and Orthopedics, and predominantly “female” fields, such as OB/GYN and Pediatrics. Similar trends were shown in Japan and France [2,12]. Additional studies support these findings and also show a tendency among women to choose Primary Care Medicine residencies (Family Medicine, Pediatrics, OB/GYN, and Psychiatry) [13,14]. The trend in Israel is similar [6]. These trends may be linked to the importance that women give to a profession’s workload and schedule flexibility and the ability to manage a family life, as was shown in studies from

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the Netherlands and Switzerland [9,15]. Men, on the other hand, tend to choose residencies that are perceived as having a higher workload. In Israel, females constitute 15% or less in these professions (Surgery, Orthopedics, Cardiology, Intensive Care) [6]. In a study among all General Practitioners in the Netherlands who graduated between 1982 and 2001, Mayorova et al. [16] argued that career choices for men are influenced more by fluctuating labor markets, while female choices are based more on family circumstances.

Since Israel does not have a medical residency-based workforce planning process, there are no means to assess gaps between demands of graduating medical students and the system's needs. This study offers a model to assess the gaps in each residency. In the absence of defined future requirements, we used the current status as a benchmark, taking into account Israel's graduating residents over the past few years. However, the model can be adjusted if such a future program is built and could be applicable worldwide. The results of this study can identify residencies in need of promotion and better exposure during medical school and can be used by health systems decision makers when planning workforce needs.

## METHODS

### THE GAP ASSESSMENT MODEL – $G_i$

A model was constructed to quantify the current residency distribution status and compare it to the residency demand. Current residency distribution was based on data received from the Scientific Council of the Israel Medical Association, including the number of graduating residents in each residency for the period 2006–2010. The relative proportion of each residency was calculated and defined as the current residency status,  $E_i$  (Existing). Next, the gap ( $G_i$ ) between the demand and the current status for each residency was rated by the formula  $G_i = \frac{D_i - E_i}{E_i}$ ,  $D_i$  being the residency's demand portion, as obtained from a students' survey (below). As an example, the demand portion for OB/GYN in the students' survey was 14.1% and the current status is 6.1%. Therefore, the residency's gap rating was  $G_{OB/GYN} = \frac{14.1 - 6.1}{6.1} = 1.3$ . According to the model, a residency with demand lower than the existing status will have a negative gap rating, (-1) being the lowest possible rating (zero demand). A certain deficit between demand and current status is less meaningful when there is a larger absolute number of residents.

### POPULATION AND DATA GATHERING

To estimate medical students' residency demands, an internet-based questionnaire was sent twice via email during July–August 2011 to all medical students at Hadassah-Hebrew University Medical School in Jerusalem, and Sackler Faculty of Medicine of Tel Aviv University – totaling approximately 1700 students. Israeli medical students at Tel Aviv University attend one of two medical studies programs: the 6 year program and the fairly new

4 year program for students with a bachelor degree. American medical students at Tel Aviv University, in the “New York program,” were given a matching questionnaire whose results were analyzed separately as a comparison group. Questionnaires were received from 917 Israeli students. Eight questionnaires were disqualified for errors. The total response rate was 53%: 58% in the Tel Aviv 6 year program (61% female), 81% in the Tel Aviv 4 year program (66% female), and 41% in the Jerusalem 6 year program (46% female). Questionnaire topics included demographics (gender, age, marital status, number of children), study program, school year, a rating of the three most preferred residencies and ratings of the importance of five considerations when choosing a residency (professional-medical contents, nature of the practical work, geographic location of the hospital, income as a specialist, and workload during the residency period) according to a Likert scale of “Not important,” “Less important,” “Relatively important” and “Very important.”

### STATISTICAL ANALYSIS

One-sample *t*-test was used to examine the hypothesis that males constituted half of the study population. Associations between gender and program and between gender and number of children were tested with the chi-square test; Fisher's exact test assessed the association between gender and marital status, between residency and gender, between clinical and pre-clinical, between first and sixth year of medical school, between the 6 and the 4 year Tel Aviv University program, and between Israeli and American students. Student's *t*-test was used to test the mean age difference between genders. The Mann-Whitney U test was used to compare gender considerations for residency choice. Each residency was defined as 1 when chosen and 0 when not. One-sample *t*-test was used to test the null hypothesis that the mean was equal to the existent current status ( $E_i$ ). Two-sided  $P < 0.05$  was considered statistically significant. Statistical analyses were performed with IBM SPSS statistics, version 19.

## RESULTS

The data for the existing status ( $E_i$ ) related to all 2203 graduating residents from 2006 to 2010. We calculated the demand for each residency ( $D_i$ ) using data from 909 Israeli medical students, age 18–38 years (mean  $26.3 \pm 3.14$ ); 513 (56.4%) were female. Student characteristics are presented in Table 1.

According to the model [Table 2] [Figure 1], Pathology, Rehabilitation Medicine, Radiology, Family Medicine, Anesthesiology, Internal Medicine, and Dermatology present a shortage in demand ( $G_i = -1, -0.9, -0.8, -0.8, -0.8, -0.5, -0.5$ , respectively), with a significant difference between demand and current status ( $P < 0.001$ , except for Dermatology,  $P = 0.012$ ). In contrast, Surgery subspecialties, Neurology, OB/GYN, Oncology, and Pediatrics showed an excess in demand ( $G_i = 2.9, 1.4, 1.3, 1.1, 0.7$ , respectively, with a significant differ-

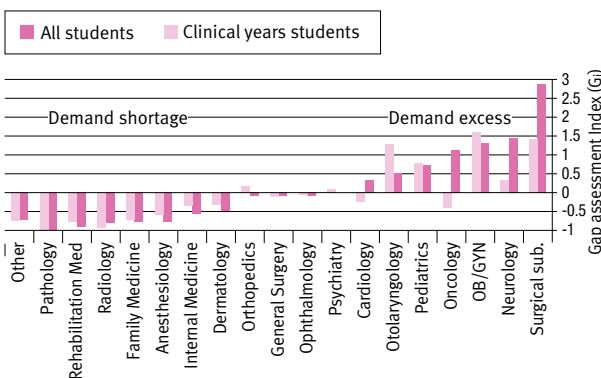
**Table 1.** The medical students study population according to the 2011 questionnaire

	Total	Male, N (%)	Female, N (%)	P value
Total responders	909 (100)	396 (43.6)	513 (56.4)	< 0.001
<b>Program</b>				
Sackler, 6 year	424	165 (41.7)	259 (50.5)	< 0.001
Sackler, 4 year	152	52 (13.1)	100 (19.5)	
Hadassah, 6 year	333	179 (45.2)	154 (30)	
Total	909	396 (100)	513 (100)	
<b>Marital status</b>				
Married	241	113 (28.5)	128 (25)	0.227
Not married	668	283 (71.5)	385 (75)	
<b>No. of children</b>				
0	802	338 (85.4)	464 (90.4)	0.005
1	71	33 (8.3)	38 (7.4)	
2 or more	36	25 (6.3)	11 (2.1)	
Mean age ± SD	26.3 ± 3.14	26.9 ± 3.32	25.8 ± 2.9	< 0.001

ence between demand and existing status,  $P < 0.001$ ). Looking at the 382 clinical-year students only,  $G_i$  values showed a decline in selection of Surgical subspecialties (1.4), Neurology (0.3) and Oncology (where  $G_{Onc}$  turned negative, to -0.4).

In analyzing all three prioritized residencies, the pattern remains the same, except for Cardiology, General Surgery and Otolaryngology, which showed significant excess in demand;

**Figure 1.** Gap assessment between student demand and existing status, by residency and phase of study



For each residency, this figure illustrates  $G_i$ , the gap assessment described in the Methods section

Orthopedics, which showed a statistically significant shortage; and Dermatology and Rehabilitation Medicine, which were similar to the existing status (as opposed to the shortage shown when only counting first priorities).

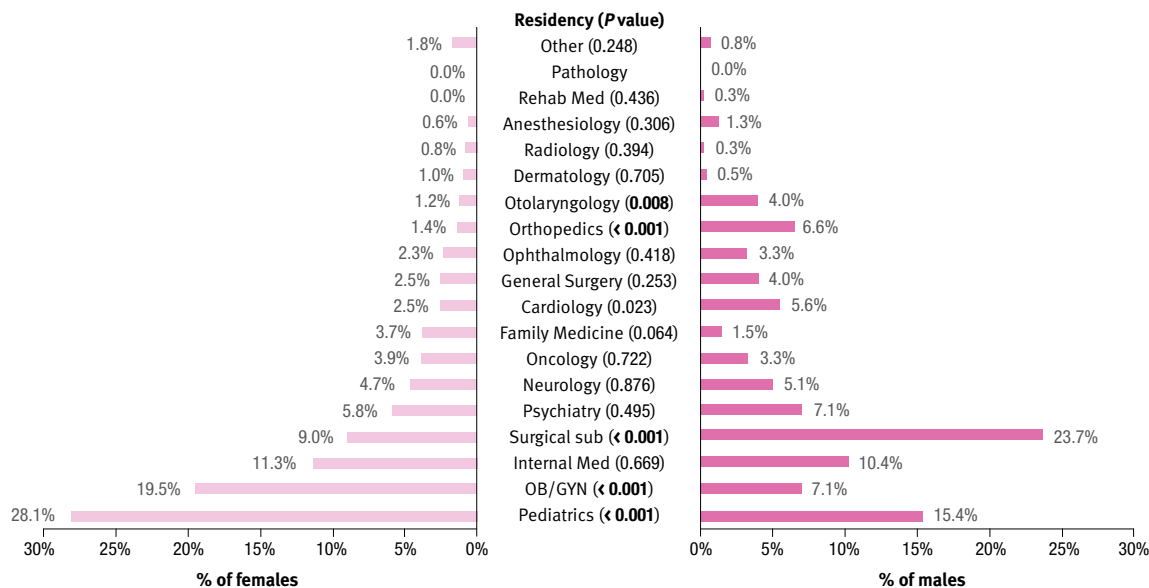
Among the responders, 527 were students in their pre-

**Table 2.** Current status of residencies, residency ratings among students in the 2011 questionnaire, and the matching gap assessment index,  $G_i$

Residency	$E_i$ , current status* No. (%)	$D_i$ , first priority No. (%)	P value	$G_i$ for first priority vs. existing status	Priorities 1–3 combined** No. (%)	P value	$G_{(1-3)}$ for priority 1–3 vs. existing status
Pathology	18 (0.8)	0 (0)	< 0.001	-1	6 (0.2)	< 0.001	-0.8
Rehabilitation Medicine	23 (1.0)	1 (0.1)	< 0.001	-0.9	26 (1)	0.807	0
Radiology	84 (3.8)	5 (0.6)	< 0.001	-0.8	34 (1.2)	< 0.001	-0.7
Family Medicine	265 (12)	25 (2.8)	< 0.001	-0.8	143 (5.2)	< 0.001	-0.6
Anaesthesia	80 (3.6)	8 (0.9)	< 0.001	-0.8	35 (1.3)	< 0.001	-0.6
Internal Medicine	532 (24.1)	99 (10.9)	< 0.001	-0.5	262 (9.6)	< 0.001	-0.6
Dermatology	34 (1.5)	7 (0.8)	0.012	-0.5	45 (1.7)	0.534	0.1
Orthopedics	95 (4.3)	33 (3.6)	0.281	-0.2	85 (3.1)	0.002	-0.3
Ophthalmology	65 (3.0)	25 (2.8)	0.646	-0.1	101 (3.7)	0.051	0.2
General Surgery	76 (3.4)	29 (3.2)	0.719	-0.1	122 (4.5)	0.007	0.3
Psychiatry	139 (6.3)	58 (6.4)	0.921	0	170 (6.2)	0.863	0
Cardiology	65 (3.0)	35 (3.9)	0.183	0.3	172 (6.3)	< 0.001	1.1
Otolaryngology	36 (1.6)	22 (2.4)	0.108	0.5	85 (3.1)	< 0.001	0.9
Pediatrics	289 (13.1)	205 (22.6)	< 0.001	0.7	439 (16.1)	< 0.001	0.2
Oncology	37 (1.7)	33 (3.6)	< 0.001	1.1	128 (4.7)	< 0.001	1.8
OB/GYN	134 (6.1)	128 (14.1)	< 0.001	1.3	330 (12.1)	< 0.001	1
Neurology	44 (2.0)	44 (4.8)	< 0.001	1.4	183 (6.7)	< 0.001	2.4
Surgical subspecialties	88 (4.0)	140 (15.4)	< 0.001	2.9	295 (10.8)	< 0.001	1.7
Other	99 (4.5)	12 (1.3)	< 0.001	-0.7	63 (2.3)	< 0.001	-0.5

\*As calculated from residency graduates data for the years 2006–2010

\*\*All three preferences were counted equally together. There were three cases without a third preference, making the total number of preferences 2724

**Figure 2.** Gender differences in first priority residency choice among students. Significant *P* values are written in bold

Rehab Med = Rehabilitation Medicine, Surgical sub = Surgical subspecialties, Internal Med = Internal Medicine, OB/GYN = Obstetrics & Gynecology

clinical years (56.7% female), 382 were in their clinical years (56% female). Clinical-year students chose particular residencies significantly less than did pre-clinical students: Surgical subspecialties (9.7% vs. 19.5%,  $P < 0.001$ ), Neurology (2.6% vs. 6.5%,  $P = 0.008$ ) and Oncology (1% vs. 5.5%,  $P < 0.001$ ). However, Internal Medicine was chosen more in clinical years (16%) than in pre-clinical years (7.2%,  $P < 0.001$ ). The same was found for Otolaryngology (3.7% vs. 1.5%,  $P = 0.048$ ). No significant differences were found in other residencies.

We also compared first-priority preferences between first and sixth year students (154 and 124 respectively) in the 6 year medical school programs. The differences in Surgical subspecialties (22.7% among first year students vs. 6.9% among sixth year students,  $P < 0.001$ ) and Internal Medicine (3.2% vs. 19.8%,  $P < 0.001$ ) were more prominent than that shown for all clinical students vs. all pre-clinical students. No sixth year students chose Oncology, while 4.5% of the first year did ( $P = 0.021$ ); 3.4% of sixth year students chose Anesthesiology, but none of the first year students did ( $P = 0.033$ ). No other significant differences were shown when comparing other residencies.

Residency preferences differed by gender [Figure 2]: 28.1% of females chose Pediatrics as a first priority compared to 15.4% of males ( $P < 0.001$ ). A difference was also found in OB/GYN, with 19.5% of females and 7.1% of males ( $P < 0.001$ ) choosing it first. The most popular residency among males was Surgical subspecialties, 23.7%, while only 9% of

females made the same choice ( $P < 0.001$ ). Cardiology (2.5% of females vs. 5.6% of males,  $P = 0.023$ ), Orthopedics (1.4% vs. 6.6%,  $P < 0.001$ ) and Otolaryngology (1.2% vs. 4%,  $P = 0.008$ ) were also significantly more preferred among males than females. No other significant gender differences were found.

Considerations given highest ratings for residency choice were professional medical contents (98.8% of responders rated it as very important/relatively important), and nature of practical work (97.9%); there was no significant gender difference. Income for a specialist was rated higher among males (73.7% very or relatively important, 26.3% less or not important) than females (58.1%, 41.9%,  $P < 0.001$ ). Workload during the residency period was rated lower among males (54.8% very or relatively important, 45.2% less or not important) than females (68.6%, 31.4%,  $P < 0.001$ ). The hospital's geographic location received the lowest rating among all students (50.6% of responders rated it as very/relatively important).

A comparison of Israeli vs. American students in the New York program (132 responders, 53% response) showed significant differences. Residencies chosen more often among American students compared to Israelis were Anesthesiology (7.6% vs. 0.9% respectively,  $P < 0.001$ ), General Surgery (9.1% vs. 3.2%,  $P = 0.003$ ), Dermatology (3.8% vs. 0.8%,  $P = 0.011$ ) and Rehabilitation Medicine (1.5% vs. 0.1%,  $P = 0.044$ ). Residencies chosen less among American students compared to Israelis were OB/GYN (6.1% vs. 14.1%,  $P = 0.008$ ) and Surgical subspecialties (4.5% vs. 15.4%,  $P < 0.001$ ).

## DISCUSSION

The model presented in this study revealed gaps in several residencies. In addition to professions already defined as “in shortage” (Pathology, Rehabilitation Medicine, Anesthesiology), Radiology and Family Medicine also showed significant gaps. The persistence of gaps in these professions requires intervention. The actual gap in Internal Medicine might even be larger than demonstrated, since many graduates of this residency will continue to specialize in specific subspecialties and leave the Internal Medicine ward. On the other hand, the increasing demand for Internal Medicine among clinical students (especially in the graduating year) might suggest that student demand is greater than the overall 10.9% shown. When focusing on demand among clinical year students (as a shorter term forecast), we see that the Neurology residency status is balanced, while there is an expected gap in Oncology.

Interestingly, Pathology, in which a grave crisis is expected in Israel due to the number of residents and the relatively older age of the specialists [17], was not chosen as first priority by any of the 909 students. Nonetheless, Pathology has not been officially declared as a profession in severe shortage. One cannot help but wonder what criteria are used to officially define “shortage” and whether this definition represents the political strength of the professional associations or the actual severity of the problem. Our model can serve as an objective method to define shortage.

Departmental exposure during the clinical years affects residency choice. For example, Internal Medicine, a profession in shortage, was chosen more among students during clinical rotations. In the same manner, Israel’s decision to include Anesthesiology and Intensive Care rounds during the mandatory internship year may contribute to their demand. Our study, indeed, shows that students in their clinical years tend to choose Anesthesiology more than pre-clinical students do. An opposite effect is expected to result from the feminization trend. This should be addressed when designing the teaching program for this profession within the clinical years. In addition to Anesthesiology, exposure during clinical years showed a positive effect on Otolaryngology and Orthopedics. However, exposure seems to negatively affect Surgical subspecialties. This might result from low exposure to specific subspecialties (as opposed to General Surgery, which did not show a major decline among students in their clinical years). If so, there’s a need to reexamine how these subspecialties are integrated in surgical rounds.

A comparison of first and sixth (last) year students showed some differences to be more extreme. The demand for Internal Medicine grew fourfold. Similarly, Anesthesiology became more popular, after not being chosen at all among first year students. Earlier exposure may therefore alleviate the present shortage in this profession.

We see that the gender-based trend described in Israel for

physicians, as well as in the international literature [2,11-14], exists also among the Israeli students. The choice for Surgery and Cardiology was characterized by a male majority, while Pediatrics, OB/GYN and Family Medicine were more female-dominated. This trend is significantly important in view of the rising female proportion in the medical profession. The primary care residencies (Family Medicine, Pediatrics, OB/GYN, Psychiatry) are the beneficiaries of this change, while the Surgical residencies are being negatively affected. Since Israel does not have a standardized process for medical workforce recruitment with a view to future needs, the described trends will inevitably widen the existing gap in these residencies, in conjunction with the continuing feminization of the medical profession. This is a scenario seemingly in disregard of the earlier mentioned recommendations given by the public committee [7], which suggested an interventional program to bring about fundamental improvement (regarding professions in shortage) and to find specific ways to manage every profession.

Addressing the relative female absence from surgical professions raises questions about their motives, whether it is the workload or the actual aspect of the residency as it is perceived by female students. Workload may be reduced by solutions focused on making it easier to conduct family life during the residency. The female perception can be influenced by, for example, female mentors and tutors during surgical rounds in clinical years who can share their experience in coping with the difficulties of the profession.

The leading residencies among students will be affected differently by the continuing feminization trend. Excess demand in Surgical subspecialties will decrease, while demand will increase in Pediatrics and OB/GYN. The OB/GYN profession, currently with a male majority among Israeli specialists (74% in 2010) [6], is the main profession undergoing a transformation as a result of feminization. The proportion of females choosing this residency was almost three times higher than among males.

Paradoxically, females’ tendency to consider work and time-related aspects more important than was found among men [16] may worsen the hospital shortage of female-preferred residencies. As Pediatrics gains the benefit of the feminization trend, the shortage officially defined [4] in Pediatric Intensive Care and Neonatology (characterized by a high workload) may grow graver.

The ratings of considerations for residency choice are not surprising. Females considered the income of a specialist less important than males did, as already shown by Lefevre et al. among French students [18]. It is interesting to see that hospital location is considered the least important, albeit not reflected in the existing gap between hospitals located in central Israel and those located at its periphery. This point should be studied further in light of the incentives given in recent Israeli health system agreements to physicians practicing in periphery hospitals.

The differences shown between the Israeli and American



students are most likely influenced by the different income levels and workload of certain residencies in Israel and the USA, as was previously shown for Anesthesiology among the Tel Aviv medical students [19].

The strength of this study is that it demonstrates a generic model that can be applicable in all countries to assess future gaps in the medical workforce and the influence that medical school has on residency demand.

The study has some limitations. The existing status of graduating residents is only an approximation for the system's real needs as it includes already existing gaps in several residencies. An agreement covering work conditions between the Israel Medical Association and the employers was signed after this survey [4]. This may affect the students' preferences and requires further research. Another limitation of this study is the 53% response rate. We were unable to compare the responders' characteristics to those of all the students as that information was not available to us. However, in itself, the number of responders (909) represents a large number of future physicians.

In conclusion, the Gap Assessment Model can serve as an objective method to define shortage. It provides a partial response since it does not reflect future trends. Its value is its simplicity and its unique ability to identify and quantify gaps. It is important to consider student preferences and considerations; these reflect near-future residency demand and provide information for the decision-makers regarding expected gaps. For medical education, it alludes to the need for changes in how the clinical years are built and organized, which may induce future residents to choose residencies that are currently in shortage.

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### Capsule

#### Bidirectional regulation of neutrophil migration by mitogen-activated protein kinases

To kill invading bacteria, neutrophils must interpret spatial cues, migrate and reach target sites. Although the initiation of chemotactic migration has been extensively studied, little is known about its termination. Liu et al. found that two mitogen-activated protein kinases (MAPKs) had opposing roles in neutrophil trafficking. The extracellular signal-regulated kinase Erk potentiated activity of the G protein-coupled receptor kinase GRK2 and inhibited neutrophil migration, whereas the

MAPK p38 acted as a non-canonical GRK that phosphorylated the formyl peptide receptor FPR1 and facilitated neutrophil migration by blocking GRK2 function. Therefore, the dynamic balance between Erk and p38 controlled neutrophil 'stop' and 'go' activity, which ensured that neutrophils reached their final destination as the first line of host defense.

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