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Knowledge and attitudes of primary care physicians regarding acromegaly: a survey study with multinational participation

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Abstract

Background Acromegaly is a disease with high morbidity and mortality rates. The role of primary care physicians is very important in the early diagnosis of acromegaly. The present study aims to determine the knowledge and attitudes of primary care physicians about acromegaly in different countries worldwide.

Methods The survey consisted of 33 questions prepared in English and Turkish and was administered to a total of 396 primary care physicians, 280 of whom were from Turkey, 84 from European countries, 28 from Asian countries, and 4 from Nigeria. Mostly, the survey was administered via Google Forms sent to social media groups of primary care physicians. Some of the surveys were administered in person. The survey included 12 questions about the clinical manifestations, six questions about the diagnosis, 12 questions about the comorbidities, one question about the treatment, and two questions about the prognosis of acromegaly. Data of acromegaly knowledge and the attitudes of physicians were evaluated using the chi-square test.

Results The presence of acral findings in acromegaly was better known by Turkish physicians (96.8%) compared to Asian/African (84.4%) and European (84.5%) physicians ($p < 0.001$). The presence of generalized visceromegaly and excessive sweating was better known by Asian/African physicians ($p = 0.01$ and $p = 0.009$, respectively). The rate of correct answers to the question "Old photographs can be informative in patients suspected to have acromegaly" was higher in the Turkish and Asian/African groups ($p < 0.001$). Only 36.1% of the Turkish physicians, 29.8% of the European physicians, and 31.3% of the Asian/African physicians knew that serum growth hormone (GH) and insulin-like growth factor-1 (IGF-1) levels were diagnostic indicators for acromegaly. Colon cancer and goitre incidences were increased in acromegaly patients. These comorbidities were better known by Asian/African primary care physicians than by Turkish and European primary care physicians ($p < 0.001$ and $p = 0.032$, respectively). Only 18.6% of Turkish and 13% of European physicians knew that surgery was the treatment of choice for acromegaly patients. The rate of correct answers to this question was higher for Asian/African physicians (59.4%) ($p = 0.003$).

Conclusion Knowledge of primary care physicians regarding acromegaly should be increased through workshops, seminars, and subject-focused courses.

Keywords Acromegaly, Primary care, Knowledge, Attitudes

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Background

Acromegaly is a rare, endocrinological disease caused by the chronic excessive secretion of growth hormone (GH) and insulin-like growth factor-1 (IGF-1) [1]. Due to the long-term exposure of tissues to GH and IGF-1, many comorbidities such as cardiovascular, respiratory, metabolic, musculoskeletal, neurological, and neoplastic diseases may occur [2]. A review by Lavrentaki et al. (2017) revealed that the prevalence of acromegaly ranged between 2.8 and 13.7 cases per 100,000 people, and the annual incidence ranged between 0.2 and 1.1 cases per 100,000 people. The median age at diagnosis was in the fifth decade of life [3]. Acromegaly is a disease with high morbidity and mortality rates. A timely diagnosis reduces the mortality of patients and improves their quality of life [1, 4].

Most acromegaly patients have pituitary macroadenomas, and 60% of pituitary tumors are pure somatotroph adenomas that secrete only GH. Pituitary adenomas that secrete GH and prolactin are observed in 25% of cases. Adenomas that secrete TSH or ACTH with GH and carcinomas that secrete GH are rare. Hypothalamic tumors that secrete growth hormone-releasing hormone (GHRH) and pancreatic or bronchial carcinoid tumors may cause acromegaly by triggering an excessive secretion of GH [5].

Due to growth in soft tissues and bones, enlargement of the hands and feet and thickening of the fingers are observed in acromegaly patients. The size of shoes and rings may increase. Changes that occur on the face include prominence in the forehead, chin, and cheekbones; thickening of the lips; coarsening of facial lines due to nose widening; and malocclusion. There may be hoarseness in the voice due to hypertrophy in the sinuses and larynx. Macroglossia may be observed [1, 2, 5]. The frequency of carpal tunnel syndrome, degenerative arthritis, and vertebral fractures is increased in patients with acromegaly. Myalgia and arthralgia are observed in 30–70% of patients. Increased thickness and oiliness of the skin, increased sweating, and acanthosis nigricans are skin findings. Generalized visceromegaly may occur [1, 5].

Hypertension is very common, occurring in 20–50% of patients, and its prevalence increases with the duration of the disease. Atherosclerosis, coronary artery disease, cardiomyopathy, arrhythmias, congestive heart failure, and heart valve diseases are other cardiovascular complications [5, 6]. Diabetes mellitus, insulin resistance, glucose intolerance, hyperlipidaemia, hypothyroidism, and goitre are metabolic complications. Frequent headaches, sleep apnea, and oligomenorrhea are atypical clinical manifestations associated with acromegaly [1, 2, 5]. The Endocrine Society Clinical Practice Guidelines suggest screening for acromegaly by measuring IGF-I in patients with typical clinical manifestations and in patients who lack a typical clinical picture [7].

Factors that delay the diagnosis of acromegaly are the slow onset of acromegaly symptoms, the presentation of physical findings over a long period and failure of patients and their relatives to notice changes, the consultation of different specialists by patients for a wide range of complaints, and the failure of physicians to consider the diagnosis of acromegaly. During this delay, complications and mortality rates increase [1]. In the context of a comprehensive approach and specific problem-solving skills, the role of primary care physicians is crucial for diagnosing acromegaly based on this wide range of clinical manifestations. The present study aims to determine the knowledge and attitudes of primary care physicians about acromegaly in different countries worldwide.

Methods

Study design and study population

This cross-sectional descriptive study was performed between December 2020 and November 2023 via the administration of a survey to primary care physicians from various nations. A total of 396 questionnaires were administered, and the response rate to the questions was 100%. The inclusion criteria for our study were primary care physicians, family medicine specialists, or family medicine residents working in family health centres, hospitals, or universities in Turkey and different countries worldwide.

Data from 280 primary care physicians from Turkey, 84 from European countries, 28 from Asian countries, and 4 from Africa were obtained from the survey. The European physicians who participated in the study were ten physicians from Germany, five from the Netherlands, five from Romania, six from England, eleven from North Macedonia, eight from Serbia, nine from France, two from Sweden, four from Slovenia, three from Portugal, six from Spain, seven from Belgium, three from Ireland, and five physicians from Croatia. The Asian physicians who participated in the study were nine physicians from Pakistan, eight from Malaysia, three from Georgia, six from Israel, and two physicians from Malta. The African physicians who participated in the study were four physicians from Nigeria.

Data collection

The questionnaire used in this study was developed for this study and has not been previously published elsewhere. It consisted of 33 questions that were prepared by A.K.F., P.K., C.S., and H.M.O. The questionnaire was prepared in English and Turkish. Twelve of the questions were related to the clinical manifestations of acromegaly,

six were about the diagnosis of acromegaly, twelve were related to the comorbidities associated with acromegaly, one was about treatment, and two were about the prognosis of acromegaly. The respondents were asked to respond "agree" or "disagree/have no idea" to the questions.

Mostly, the survey was administered via Google Forms sent to social media groups of primary care physicians. Some surveys were administered in person during the meetings and congresses of primary care physicians. The in-person surveys were administered by A.K.F. The entire survey took 15 min to complete.

The answers to the questions were examined in three groups: Turkey, Europe, and Asia and Africa. The comparisons between these groups aimed to reveal the knowledge, attitudes, and behaviours of primary care physicians about acromegaly according to the regions where the participants worked.

Statistical analysis

Data regarding the acromegaly knowledge and attitudes of Turkish physicians, European physicians, and Asian and African physicians were evaluated using the chi-square test, and the results are presented in Tables 1, 2, 3, and 4. The data in the tables are presented as percentages and numbers. *P*-values less than 0.05 were considered statistically significant. The data were entered and analysed using SPSS for Windows version 16.0 (SPSS Inc; Chicago, IL, USA).

Ethical considerations

We conducted this study in compliance with the Declaration of Helsinki. All physicians who participated in the study in person signed a written informed consent before participating. Physicians who participated via a Google form approved the informed consent section, which was added to the questionnaire. The Clinical Research Ethics Committee of Istanbul University-Cerrahpasa, Cerrahpasa Medical Faculty (approval date and number 21.10.2020–139312), approved the study.

Results

A total of 396 questionnaires were administered, and the response rate to the questions was 100%. Out of the physicians who participated in the study, 280 were from Turkey, 84 were from Europe, and 32 were from Asia and Africa. The answers to the questions were compared among these three groups (Tables 1, 2, 3, and 4).

Table 1 shows the comparison of the knowledge of primary care physicians about the clinical manifestations of acromegaly. There was no statistical significance in questions related to the visual findings of acromegaly, and most of the physicians answered this question correctly. Questions about the acral findings, excessive sweating, and generalised visceromegaly in patients with acromegaly revealed a statistically significant difference among the groups. The presence of acral findings in patients with acromegaly was better known by Turkish physicians (96.8%) compared to Asian/African (84.4%) and European (84.5%) physicians ($p<0.001$). Although most Asian/African physicians (81.3%) knew that patients complaining of excessive sweating may have had acromegaly, only half of the Turkish and European physicians answered this question correctly ($p=0.009$). The presence of generalised visceromegaly in patients with acromegaly was also better known by Asian/African physicians compared to Turkish and European physicians (78.1% vs. 62.1% and 48.8%, respectively) ($p=0.01$). Although most of the primary care physicians answered correctly, the rate of correct answers to the question "Old photographs can be informative in patients suspected to have acromegaly" was higher in the Turkish and Asian/African groups ($p<0.001$). Galactorrhoea may be observed in patients with acromegaly, and half of the Turkish and Asian/African physicians disagreed with the misleading question about galactorrhoea. There was a statistically significant difference in the comparison of the groups for this question ($p=0.01$). Snoring in an underweight patient may be suggestive of acromegaly. This clinical finding was better known by Asian/African physicians (65%) compared to Turkish (28.6%) and European (44%) physicians ($p<0.001$).

Table 2 shows the comparison of the knowledge of the primary care physicians about the diagnosis of acromegaly. The diagnosis of acromegaly is made primarily on the basis of serum GH and IGF-1 levels and the demonstration of pituitary adenoma via radiological imaging. Only 36.1% of Turkish physicians, 29.8% of European physicians, and 31.3% of Asian/African physicians knew that serum GH and IGF-1 levels were diagnostic tests for acromegaly. Although 64.3% of the Turkish physicians knew that the serum IGF-1 level was the single best test for patients suspected of having acromegaly, the rate of correct answers to this question was low for European (36.9%) and Asian/African (46.9%) physicians ($p<0.001$). The percentage of physicians who knew that the diagnosis of acromegaly should be made via demonstration of macroadenoma was higher in Asian/African (78.1%) physicians than in Turkish (59.3%) and European (52.4%) physicians ($p=0.041$). However, 100% of Asian/African physicians knew that asymptomatic patients with pituitary macroadenomas may have acromegaly. There was a statistically significant difference when this rate was compared to the rates of Turkish (63.6%) and European (46.4%) physicians ($p<0.001$). Notably, the OGTT is used to stimulate GH for the diagnosis of acromegaly. The

Table 1 Answers About the Clinical Manifestations of Acromegaly

	Turkey (N = 280)		Europe (N = 84)		Asia and Africa (N = 32)		P value
	N	%	N	%	N	%	
I will consider the diagnosis of acromegaly in patients admitted with acral findings							
Disagree / No idea	9	3.2	13	15.5	5	15.6	
Agree	**271**	**96.8**	71	84.5	27	84.4	**< 0.001**
Patients with coarse facial features may have acromegaly disease							
Disagree / No idea	14	5	4	4.8	0	0	
Agree	266	95	80	95.2	32	100	0.435
Patients complaining of excessive sweating may have acromegaly							
Disagree / No idea	132	47.1	38	45.2	6	18.8	
Agree	148	52.9	46	54.8	**26**	**81.3**	**0.009**
Acromegaly patients may suffer from peripheral oedema							
Disagree / No idea	129	46.1	27	32.1	15	46.9	
Agree	151	53.9	57	67.9	17	53.1	0.071
Old photographs can be informative in patients suspected to have acromegaly							
Disagree / No idea	5	1.8	9	10.7	0	0	
Agree	**275**	**98.2**	75	89.3	**32**	**100**	**< 0.001**
Acromegaly patients may present with headache							
Disagree / No idea	40	14.3	18	21.4	3	9.4	
Agree	240	85.7	66	78.6	29	90.6	0.174
Menstrual irregularity can be found in acromegaly patients							
Disagree / No idea	42	15	18	21.4	2	6.3	
Agree	238	85	66	78.6	30	93.8	0.113
Acromegaly patients may have generalized visceromegaly							
Disagree / No idea	106	37.9	43	51.2	7	21.9	
Agree	174	62.1	41	48.8	25	78.1	**0.01**
Galactorrhoea is not seen in patients with acromegaly							
Agree / No idea	124	44.3	50	59.5	15	46.9	
Disagree	**156**	**55.7**	34	40.5	17	53.1	**0.049**
Acromegaly patients do not have							
Agree / No idea	120	42.9	43	51.2	20	62.5	
Disagree	160	57.1	41	48.8	12	37.5	0.063
Acromegaly patients may present with visual problems							
Disagree / No idea	42	15.0	20	23.8	3	9.4	
Agree	238	85.0	64	76.2	29	90.6	0.086
Snoring in an underweight patient can be suggestive of acromegaly							
Disagree / No idea	200	71.4	47	56	11	34.4	
Agree	80	28.6	37	44	**21**	**65.6**	**< 0.001**

Chi-square test

percentage of physicians who answered the misleading question correctly was greater among European physicians (57.1%) than among Turkish (54.6%) and Asian/African (31.3%) physicians ($p = 0.031$).

Table 3 shows the comparison of the answers concerning the comorbidities observed in patients with acromegaly. Colon cancer incidence is increased in acromegaly patients. The percentage of primary care physicians who answered this question correctly was higher in Asian/African (53.1%) physicians and lower in European (17%) physicians ($p < 0.001$). Although most Turkish (97.1%) and European (96.4%) primary care physicians knew that acromegaly patients may have cardiomegaly and hypertension, 87.5% of Asian/African physicians answered this question correctly ($p = 0.025$). Goitre incidence is increased in acromegaly

Table 2 Answers About the Diagnosis of Acromegaly

	Turkey (N = 280)		Europe (N = 84)		Asia and Africa (N = 32)		P value
	N	%	N	%	N	%	
Serum GH and IGF-1 levels are diagnostic tests for acromegaly							
Disagree / No idea	179	63.9	59	70.2	22	68.8	
Agree	101	36.1	25	29.8	10	31.3	0.525
Most of the patients with acromegaly have macroadenoma							
Disagree / No idea	114	40.7	40	47.6	7	21.9	
Agree	166	59.3	44	52.4	**25**	**78.1**	**0.041**
Acromegaly patients may have increased serum insulin and phosphorus levels							
Disagree / No idea	109	38.9	38	45.2	12	37.5	
Agree	171	61.1	46	54.8	20	62.5	0.556
Serum IGF-1 level is the single best test to be chosen in patients suspected to have acromegaly							
Disagree / No idea	100	35.7	53	63.1	17	53.1	
Agree	**180**	**64.3**	31	36.9	15	46.9	**< 0.001**
Oral glucose tolerance testing has no role in the diagnosis of acromegaly							
Agree / No idea	127	45.4	36	42.9	22	68.8	
Disagree	**153**	**54.6**	**48**	**57.1**	10	31.3	**0.031**
Asymptomatic patients with pituitary macroadenoma may have acromegaly							
Disagree / No idea	102	36.4	45	53.6	0	0	
Agree	178	63.6	39	46.4	**32**	**100**	**< 0.001**

Chi-square test

patients. This comorbidity was better known by Asian/African primary care physicians (68.8%) than by Turkish (47.9%) and European (41.7%) primary care physicians ($p = 0.032$). The presence of infertility, sleep apnoea, carpal tunnel syndrome, degenerative arthritis, and other pituitary hormone deficiencies are also comorbidities observed in acromegaly patients. The knowledge of primary care physicians about these comorbidities was sufficient.

Table 4 shows the knowledge of primary care physicians about the treatment and prognosis of acromegaly patients. The mortality rate is increased in patients with acromegaly, and knowledge of primary care physicians about prognosis was sufficient. Surgery is the treatment of choice for acromegaly patients. Only 18.6% of Turkish and 13% of European primary care physicians answered this question correctly. The rate of correct answers to this question was higher among Asian/African primary care physicians (59.4%), and the difference was statistically significant ($p = 0.003$). Most of the primary care physicians agreed that they would consult an endocrinologist for patients with suspected acromegaly.

Discussion

Since acromegaly is a disease with high mortality and morbidity rates, early diagnosis is crucial. The role of primary care physicians, who are responsible for primary and secondary preventive medicine services, is very important at this point. The present study explored the thorough knowledge of primary care physicians from various nations about acromegaly. Although full participation from every country was not possible, primary care physicians from various countries could be reached, albeit in small numbers.

Many different studies have shown that patients with acromegaly are diagnosed approximately 5–10 years after the onset of their symptoms [8–10]. Uncertainty in the period before diagnosis creates anxiety in patients. Frequently, patients consult family physicians, gastroenterologists, gynaecologists, orthopaedists, endocrinologists, neurosurgeons, cardiologists, ophthalmologists, pulmonologists, ear-nose-throat specialists, and dentists for their undifferentiated complaints until the correct diagnosis is made [11, 12]. It has been determined that this situation creates distrust in the health care system. In interviews with acromegaly patients in the USA, patients

Table 3 Answers About Comorbidities

	Turkey (N = 280)		Europe (N = 84)		Asia and Africa (N = 32)		P value
	N	%	N	%	N	%	
Patients with acromegaly may have impaired glucose tolerance							
Disagree/ No idea	29	10.4	16	19	2	6.3	
Agree	251	89.6	68	81	30	93.8	0.057
Acromegaly patients may have sleep apnoea							
Disagree/ No idea	51	18.2	23	27.4	8	25	
Agree	229	81.8	61	72.6	24	75	0.157
Colon cancer incidence is increased in patients with acromegaly							
Disagree/ No idea	165	58.9	72	85.7	15	46.9	
Agree	**115**	**41.1**	12	14.3	**17**	**53.1**	**< 0.001**
Acromegaly patients may have carpal tunnel syndrome							
Disagree/ No idea	54	19.3	25	29.8	7	21.9	
Agree	226	80.7	59	70.2	25	78.1	0.124
Degenerative arthritis is not expected in acromegaly patients							
Agree/ No idea	83	29.6	25	29.8	13	40.6	
Disagree	197	70.4	59	70.2	19	59.4	0.435
Acromegaly patients may have cardiomegaly and hypertension							
Disagree/ No idea	8	2.9	3	3.6	4	12.5	
Agree	**272**	**97.1**	**81**	**96.4**	28	87.5	**0.025**
Goitre incidence is increased in acromegaly patients							
Disagree/ No idea	146	52.1	49	58.3	10	31.3	
Agree	134	47.9	35	41.7	**22**	**68.8**	**0.032**
Acromegaly patients may have infertility							
Disagree/ No idea	57	20.4	10	11.9	5	15.6	
Agree	223	79.6	74	88.1	27	84.4	0.196
Acromegaly patients may have hypothyroidism							
Agree/ No idea	258	92.1	82	97.6	30	93.8	
Disagree	22	7.9	2	2.4	2	6.3	0.206
Psychiatric disorders are common findings in acromegaly patients							
Disagree/ No idea	122	43.6	33	39.3	12	37.5	
Agree	158	56.4	51	60.7	20	62.5	0.671
Acromegaly patients may have hyperthyroidism							
Disagree/ No idea	166	59.3	46	54.8	12	37.5	
Agree	114	40.7	38	45.2	20	62.5	0.058
Acromegaly patients may have other pituitary hormone deficiencies							
Disagree/ No idea	44	15.7	23	27.4	6	18.8	
Agree	236	84.3	61	72.6	26	81.3	0.054

Chi-square test

stated that primary care physicians must be better educated about acromegaly, and endocrinologists and primary care physicians should work together [11].

Primary health care is normally the point of first medical contact within the health care system. Most studies show that patients most often consult family physicians before acromegaly is diagnosed, but the diagnosis of acromegaly is most often made by endocrinologists [12–14]. However, Reid et al. reported that half of acromegaly patients were diagnosed by primary care physicians [8]. Zarool-Hassan et al. reported that most acromegaly patients were in contact with general practitioners (GPs) and/or dentists before diagnosis, and endocrinologists had the highest diagnosis rate, followed by GPs [12]. When women and men were compared, women were diagnosed later, had more

Table 4 Answers About the Treatment and Prognosis of Acromegaly

	Turkey (N = 280)		Europe (N = 84)		Asia and Africa (N = 32)		P value
	N	%	N	%	N	%	
Surgery is the treatment of choice in acromegaly patients							
Disagree / No idea	228	81.4	58	69	19	59.4	
Agree	52	18.6	26	31	**13**	**40.6**	**0.003**
Mortality rate is increased in acromegaly patients							
Disagree / No idea	48	17.1	13	15.5	10	31.3	
Agree	232	82.9	71	84.5	22	68.8	0.115
I will consult the patients suspected of acromegaly with endocrinology							
Disagree / No idea	12	4.3	3	3.6	2	6.3	
Agree	268	95.7	81	96.4	30	93.8	0.817

Chi-square test

diverse symptoms, and consulted more physicians until their diagnosis [9, 13].

It is estimated that most cases of acromegaly remain undiagnosed. The prevalence of acromegaly patients in primary health care is much higher than predicted rates [15, 16]. Schneider et al. assessed the prevalence of acromegaly in primary care by screening for elevated IGF-1 levels and reported a high prevalence of undiagnosed acromegaly in their study population [15]. A study in Latin America recommended identifying target groups and performing screening for the early diagnosis and treatment of acromegaly [17].

For the diagnosis of acromegaly, all guidelines of consensus groups emphasize the importance of detecting diagnostic clues in the patient's history and physical examination before any laboratory testing [18]. In our survey, there were a significant number of questions about the clinical manifestations of acromegaly, and primary care physicians could not answer some of these questions correctly (Table 1). However, the most reliable diagnostic tool for a family physician is frequently the physical examination. The latest consensus on criteria for acromegaly diagnosis recommends that serum IGF-1 level is sufficient for laboratory diagnosis and there is no need to check GH level [19]. In our study, only 36.9% of European primary care physicians and 46.9% of African and Asian primary care physicians knew that serum IGF-1 level was the single best test to be chosen in patients suspected to have acromegaly (Table 2). The 2020 consensus on acromegaly comorbidities indicates that hypertension is the major cardiovascular comorbidity in acromegaly, but left ventricular hypertrophy may be less frequent than earlier guidelines suggested. In our survey, most of the primary care physicians agreed that both hypertension and cardiomegaly could be present in acromegaly patients. All other comorbidities we asked about in our survey were consistent with the 2020 consensus on acromegaly comorbidities [19]. Our study detected the lack of knowledge of family physicians about the increased incidence of colon cancer in acromegaly patients. This comorbidity is important because its presence significantly affects the prognosis of the disease. The latest consensus about the management of acromegaly indicates that tumor resection via transsphenoidal surgery is the optimal primary treatment in most patients, and medical therapy should be recommended for patients who do not achieve biochemical control after surgery [20]. Our study revealed that the knowledge of primary care physicians about the management of acromegaly is not sufficient (Table 4).

New diagnostic tools for the diagnosis of acromegaly

Clinical scoring systems and artificial intelligence programs are being developed to assist physicians in the diagnosis of acromegaly. A two-question survey was prepared for use in primary health care institutions and asked whether shoe size and ring size have increased [16]. The 14-point ACROSCORE (symptom/sign scoring tool for acromegaly) system was created for the clinical diagnosis of acromegaly [21]. The SAGIT (signs and symptoms (S), associated comorbidities (A), GH levels (G), IGF-1 levels (I), Tumour profile (T)) is an instrument developed by endocrinologists to help make acromegaly diagnosis, courses, and treatment decisions. It includes signs and symptoms, associated comorbidities, growth hormone and IGF-1 levels, and tumour profile [22]. The ACROmegaly Disease Activity Tool (ACRODAT) is a program created to determine disease activity in acromegaly patients, and this tool uses: the IGF-1 level, tumour status, presence of comorbidities, symptoms, and

quality of life as the five parameters [23]. Artificial intelligence programs that can diagnose acromegaly using photographs of patients have been developed in various countries. These programs are superior to physicians in detecting acromegaly. The widespread use of artificial intelligence may increase the diagnosis rate of acromegaly [24, 25].

Strengths and limitations

To the best of our knowledge, this is the first study measuring the knowledge and attitudes of primary care physicians from different countries regarding acromegaly. The limitation of our study is that a higher number of participants from countries other than Turkey could not be obtained as much as from Turkey. Although attempts were made to reach out to primary care physicians via various social media groups, it was very challenging to recruit participants from other countries. It was almost impossible to administer the survey to primary care physicians from every country, especially physicians from the African continent. Therefore, the number of primary care physicians from Africa was limited to four physicians. For this reason, we grouped together the survey results from Asian and African countries for the comparisons. Meanwhile, since it was impossible to find equal numbers of participants from each country, and the number of participants from some countries was very small, statistical comparisons could not be made on a country basis. Another limitation of our study is that the total years of working experience of the participants was not included among the questions. The rate of correct answers could differ according to the experience of the participants.

The strengths of our study are that it revealed the sufficiencies and insufficiencies of the primary care physicians regarding the clinical manifestations, diagnosis, comorbidities, morbidity, and treatment of acromegaly. Primary care physicians knew the facial and acral findings of acromegaly, but their knowledge of the possibility of visceromegaly and galactorrhoea in these patients was poor. Most primary care physicians did not know that most acromegaly patients had macroadenomas and that the serum IGF-1 level was the single best test for patients with suspected acromegaly. Primary care physicians also lacked knowledge about the comorbidities of acromegaly. The most significant insufficiencies regarding comorbidities were the lack of knowledge about the increased risk of colon cancer and the incidence of goitre in patients with acromegaly. Our most striking finding was that most primary care physicians did not know that surgery is the treatment of choice for acromegaly patients. The most important strength of our study is that we revealed the knowledge gaps of primary care physicians regarding every aspect of acromegaly.

Conclusion

The slow onset of symptoms, the occurrence of physical changes over a long period that can be easily missed by the patient and their relatives, the consultation by patients with specialist physicians in different branches for different complaints, and the failure of physicians to consider acromegaly delay the proper diagnosis. During this period, the number and severity of complications increase, and patients continue to consult different physicians. Although technology has developed over the years, there has been no significant difference in the time from the onset of complaints to diagnosis or the tumour size at diagnosis, in the last 25 years. Clinical scoring systems and artificial intelligence programs have been developed to assist physicians; however, the knowledge and attitudes of physicians are the most important factors regarding the diagnosis of acromegaly. Early diagnosis of acromegaly, which causes many complications in patients, psychosocial problems, increased risk of mortality, and economic burden on the health care system, is very important. Treatment should be started as early as possible to prevent permanent effects. The role of primary care physicians is very important in the early diagnosis of acromegaly. Therefore, their knowledge about acromegaly should be increased through workshops, seminars, and subject-focused courses.

Abbreviations

IGF-1	Insulin-like growth factor-1
GH	Growth hormone
GP	General practitioner
SAGIT	Signs and symptoms (S), associated comorbidities (A), GH levels (G), IGF-1 levels (I), tumour profile (T)
ACRODAT	ACROmegaly Disease Activity Tool
ACROSCORE	Symptom/sign scoring tool for acromegaly

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Authors' contributions

A.K.F. conceptualized the study together with P.K., C.S., H.M.O. The survey questions were prepared by P.K., A.K.F., C.S. and H.M.O. The survey was conducted by A.K.F. and E.U.D. The statistical analysis was done by G.C. Writing of the manuscript was done by A.K.F. and E.U.D. The review and editing of the manuscript were done by N.T.S. and G.C.

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Data availability

The data are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate

We conducted this study in compliance with the Declaration of Helsinki. All physicians who participated in the study in person signed a written informed consent before participating. Physicians who participated via a Google form approved the informed consent section, which was added

to the questionnaire. The Clinical Research Ethics Committee of Istanbul University-Cerrahpasa, Cerrahpasa Medical Faculty (approval date and number 21.10.2020–139312), approved the study.

Consent for publication
All of the authors have read and agreed to the published version of the manuscript.

Competing interests
The authors declare no competing interests.

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