Questionnaire survey on educational experience, knowledge, and perceptions regarding generic medicines for pharmacists

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Abstract

　　We surveyed hospital and community pharmacists about their educational experience regarding generic medicines （GE）during their pharmacy school years and after they started working and explored whether there were differences in their knowledge and perceptions of GE based on whether they were educated or not. The anonymous survey was conducted between December 1, 2019, and January 31, 2020. A total of 805 pharmacists completed the questionnaire: 535 who worked in insurance pharmacies and 270 in hospital pharmacies. Only 13.4%（n=108/805）of pharmacists received education on GE both as pharmacy students and after becoming a pharmacist. Conversely, a significant 25.2%（n=203/805）of pharmacists did not receive any associated education. Pharmacists who received education both as pharmacy students and after working as pharmacists had considerably greater knowledge of the "relevance of generic names and therapeutic areas" and "advantages （e.g., better dosing feel）of GE" than those who received no education at all. In addition, there were substantially lower negative perceptions on the quality and effectiveness of GE and considerably higher positive perceptions toward promoting GE use. According to the results of present survey, pharmacists have limited learning experience on GE, and education improves their GE knowledge and their perceptions of its effectiveness and quality, which would promote GE use. In particular, educational experiences regarding GE during their pharmacy school years would have a positive effect on their knowledge regarding GE and their perceptions. Pharmacists over 40 years of age had lower GE knowledge and perceptions than pharmacists under 39 years of age.

Key words

　　generic medicine, pharmacist, knowledge, perception, education

Introduction

　　The use of generic medicines（GE）is currently being promoted to optimize the burden of medical costs in an aging society[1]. As a result of the Japanese government's concrete efforts, including the formulation of an action program to promote the safe use of GE[2], changes to prescription forms to encourage GE use, and the introduction of an additional fee for GE use and an extra fee for generic name prescriptions, the volume share of GE in Japan has rapidly increased in recent years. However, although the target for GE volume share was set at 80% or more by the end of FY2023, the actual volume share remained at a national average of 79.0%[3], indicating that some measures to foster GE usage are needed in the future.

　　There are many patients and healthcare professionals who strongly distrust the use of GE

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because of scattered reports suggesting that GE differ in quality and efficacy compared to brand-name medicines[4-6]. A survey by the Ministry of Health, Labour and Welfare reported that approximately 20% of patients and physicians prefer to use brand-name medicines rather than GE[7]. To resolve these issues, the National Institute of Health Sciences has taken the lead in clarifying negative information on the quality of GE from an academic perspective and providing information suggesting that GE use has no particular complications. Nevertheless, awareness of this among medical professionals is not substantial[7]. In order to promote the proper use of GE in the future, it is essential that patients and physicians have appropriate and clear knowledge about the quality, efficacy, and safety of GE, and it is essential that pharmacists having appropriate knowledge and perceptions of GE provide information to patients and physicians for promoting the use of GE. However, it is not clear whether pharmacists have educational experience with GE, how much appropriate knowledge and what perceptions they have about GE, and what matters they would like to know about GE in future.

In this study, we surveyed pharmacists working in hospitals and insurance pharmacies regarding their educational experience, knowledge, and perceptions of GE. Furthermore, by comparing the differences in knowledge and perceptions of GE between pharmacists with and those without educational experience, we discuss various educational contents required regarding GE among pharmacists and the issues necessary to resolve in order to promote GE use in the future.

Methods

1. Questionnaire survey

An unmarked survey was conducted on pharmacists working in hospitals （93 facilities） and insurance pharmacies （553 facilities） in Iwate Prefecture during December 1, 2019, to January 31, 2020. Questionnaires were distributed via mail. After the survey was conducted, the questionnaires were returned in a self-addressed envelope. The participants were informed in writing about the purpose of the study, its methods, preservation of anonymity, freedom of participation, and no disadvantages due to non-participation, and their responses were considered to constitute consent to participate in the study.

The questionnaire items were as follows:

Q1: Did you attend lectures on GE as a pharmacy student （choice: yes or no）.

Q2: What did you learn about GE as a pharmacy student （multiple choice: bioequivalence studies, quality, efficacy, safety ［side effects］, economic benefits of using generics, the advantages of generics ［e.g., better dosing feel and easier administration］, medical fee system related to generics, and others）.

Q3: Did you attend lectures on GE as a pharmacist （choice: yes or no）.

Q4: What did you learn about GE as a pharmacist （same options as Q2）.

Q5: Acceptable 90% confidence interval for the ratio of blood concentration of brand-name medicines to that of GE in bioequivalence studies （choice: 80%–120%, 80%–125%, 90%–100%, 95%–100%, 95%–105%）.

Q6: What is your knowledge and perception of GE （18 items in total, see Table 3）[8].

Q7: Which topics on GE would you like to explore in future （free response）.

The response tool for Q6 was a 5-point Likert scale （1: strongly disagree; 2: disagree; 3: neither agree nor disagree; 4: agree; 5: strongly agree）.

Q8: Age and years of experience as a pharmacist. If you are working in a pharmacy, are you the managing pharmacists, is the pharmacy owner a pharmacist, and does the pharmacy promote GEs. If you are a hospital pharmacist, specify the number of hospital beds and whether the hospital uses Diagnosis Procedure Combination.

The present study was approved by the Ethics Review Committee of the Faculty of Pharmaceutical Sciences, Iwate Medical University （Approval No.: R1-2）.

2. Comparison of knowledge and perceptions of GE between pharmacists with and those without educational experience

The participants were classified into four groups depending on whether or not they had GE education

experience as a pharmacy student (Q1) or as a pharmacist (Q3):

(ⅰ) no experience as a pharmacy student and as a pharmacist;

(ⅱ) no experience as a pharmacy student while having experience as a pharmacist;

(ⅲ) having experience as a pharmacy student and no experience as a pharmacist;

(ⅳ) having experience as both a pharmacy student and a pharmacist.

The results for Q5 are shown for each group, and the results for Q6 are presented as the mean of the response values obtained from each question for each group and compared with those of the control "no experience as a pharmacy student and as a pharmacist."

3. Comparison of knowledge and perceptions of GE in two age groups

To examine whether age difference is a confounding factor for GE knowledge and perceptions, the respondents were classified into two groups: those under 39 years of age, the majority of whom had GE education experience as a pharmacy student, and those over 40 years of age, the majority of whom did not have GE experience as a pharmacy student. The percentages of correct answers to Q5 and the mean values of the responses to Q6 were compared between pharmacists who had GE education experience as a pharmacy student and those who had GE experience as a pharmacist.

4. Statistical analysis

Statistical analysis was performed using the χ^2 test for group comparisons for the understanding of bioequivalence in Q5. Age-wise comparisons were analyzed using the Mann–Whitney U test and the multiple comparison test (Steel method) was used for group comparisons regarding knowledge and perceptions of GE in Q6, and results with $P<0.05$ were considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY, USA).

Results

1. Respondent characteristics

Responses were received from 278 out of 553 insurance pharmacies and 54 out of 93 hospitals. The overall response rate was 52.3%. Out of the 544 insurance pharmacists and 284 hospital pharmacists, 535 and 270 responded, respectively, representing a total of 805 (97.2%) responses, and they were included in the analysis, excluding those with missing responses to the respondent background question. Respondents in their 30s (26.7% of the total; n=215/805) accounted for the major proportion of respondents, followed by respondents in their 20s (19.5%; n=157/805) and 50s (19.0%; n=153/805). The average number of years of pharmacist experience was 16.8 years (Table 1).

2. Educational experience and knowledge of GE gained as a pharmacy student and a pharmacist

Table 2 shows the results of the classification of the respondents into four groups (① no experience as a pharmacy student and as a pharmacist, ② no experience as a pharmacy student while having experience as a pharmacist, ③ having experience as a pharmacy student and no experience as a pharmacist, and ④ having experience as both a pharmacy student and a pharmacist) according to whether or not they had GE educational experience. Less than 50% of the pharmacists (42.0%; n=338/805) received GE education as a pharmacy student, and 46.2% (n=372/805) received GE education as a pharmacist. Relatively few pharmacists (13.4%; n=108/805) received education as both a pharmacy student and a pharmacist, with a large proportion of pharmacists being in their 20s and 30s (78.7%; n=85/108). In contrast, 25.2% (n=203/805) of the pharmacists did not receive any education on GE as both pharmacy student and a pharmacist; the majority were in their 40s, 50s, 60s, and 70s or older (83.7%; n=170/203).

The results of a survey on what was learned by the respondents who had an opportunity to study about GE as pharmacy students (n=338/805) showed that they learned more about "bioequivalence studies" (87.9%; n=297/338),

Table 1　Characteristics of the respondents

	Pharmacy	Hospital	Total
Number of responding facilities （**return rate**）	**278 / 553** （**50.3%**）	**54 / 93** （**58.1%**）	**332 / 646** （**52.3%**）
Number of responses	**535**	**270**	**805**
Age **(years)**　20s（20–29）	**93 / 535（17.4%）**	**64 / 270（23.7%）**	**157 / 805（19.5%）**
30s（30–39）	**134 / 535（25.0%）**	**81 / 270（30.0%）**	**215 / 805（26.7%）**
40s（40–49）	**98 / 535（18.3%）**	**47 / 270（17.4%）**	**145 / 805（18.0%）**
50s（50–59）	**97 / 535（18.1%）**	**56 / 270（20.7%）**	**153 / 805（19.0%）**
60s（60–69）	**90 / 535（16.8%）**	**20 / 270（7.4%）**	**110 / 805（13.7%）**
Over 70s	**23 / 535（4.3%）**	**2 / 270（0.7%）**	**25 / 805（3.1%）**
Years of pharmacist experience （**Mean ± S.D.**）	**17.3 ± 13.0**	**15.7 ± 12.1**	**16.8 ± 12.7**
Registered pharmacist	**227 / 535（42.4%）**	-	-
Pharmacy manager is a pharmacist	**282 / 535（52.7%）**	-	-
Pharmacy promotes GE use	**515 / 535（96.3%）**	-	-
Number of beds　40–100	-	**32 / 270（11.9%）**	-
101–200	-	**67 / 270（24.8%）**	-
201–300	-	**38 / 270（14.1%）**	-
301–400	-	**30 / 270（11.1%）**	-
401–500	-	**30 / 270（11.1%）**	-
Over 500	-	**73 / 270（27.0%）**	-
Facilities covered by DPC	-	**152 / 270（56.3%）**	-

DPC: Diagnosis Procedure Combination

Table 2　Educational experience of GE as a pharmacy student and as a pharmacist

Educational experience	Total	① Students（-） Pharmacists（-）	② Students（-） Pharmacists（+）	③ Students（+） Pharmacists（-）	④ Students（+） Pharmacists（+）
Respondents	**805（100.0%）**	**203（25.2%）**	**264（32.8%）**	**230（28.6%）**	**108（13.4%）**
Age **(years)**　20s（20–29）	**157（100.0%）**	**7（4.5%）**	**1（0.6%）**	**119（75.8%）**	**30（19.1%）**
30s（30–39）	**215（100.0%）**	**26（12.1%）**	**43（20.0%）**	**91（42.3%）**	**55（25.6%）**
40s（40–49）	**145（100.0%）**	**58（40.0%）**	**56（38.6%）**	**18（12.4%）**	**13（9.0%）**
50s（50–59）	**153（100.0%）**	**68（44.4%）**	**80（52.3%）**	**1（0.7%）**	**4（2.6%）**
60s（60–69）	**110（100.0%）**	**34（30.9%）**	**69（62.7%）**	**1（0.9%）**	**6（5.5%）**
Over 70s	**25（100.0%）**	**10（40.0%）**	**15（60.0%）**	**0（0.0%）**	**0（0.0%）**
Pharmacists at insurance **pharmacies**	**535（100.0%）**	**144（26.9%）**	**190（35.5%）**	**135（25.2%）**	**66（12.4%）**
Hospital pharmacists	**270（100.0%）**	**59（21.9%）**	**74（27.4%）**	**95（35.2%）**	**42（15.5%）**
Years of pharmacist experience （**Mean ± S.D.**）	**16.8 ± 12.7**	**24.0 ± 12.2**	**23.4 ± 11.3**	**5.4 ± 5.4**	**10.0 ± 8.0**

（+）：Educational experience
（-）：No educational experience

"economic benefits of GE use"（82.3%; n=280/338）, "quality"（60.0%; n=203/338）, "efficacy"（65.4%; n=211/338）, and "safety（such as side effects）"（60.7%; n=205/338）, but less about "advantages of GE"（32.8%; n=111/338）and "medical fee system regarding GE"（25.4%; n=86/338; data not shown）. Contrastingly, for respondents who had the opportunity to study about GE as a pharmacist（n=372/805）, the results of the survey on what they learned was 55.0% or higher for all items, indicating that they generally had the opportunity to receive education without bias（data not shown）.

3. Recognition of bioequivalence test

The percentage of respondents who selected the correct answer of 80%–125% for the question "What is the acceptable range of 90% confidence interval for the ratio of blood concentration of brand-name medicines to that of GE in bioequivalence studies?"（Q5）was low, ranging from 40% to 50%, with no significant difference between the groups（P=0.10）. The percentage of correct responses was less than 50%, regardless of whether the respondent had educational experience as a pharmacy student or as a pharmacist（Figure 1）.

When compared by age, the percentage of correct responses was higher from pharmacists over 40 years of age than from those under 39 years of age among all respondents（total）and from pharmacists with no educational experience at all（①）（P<0.01）（Figure 2）.

4. Knowledge and perceptions regarding GE

Results for knowledge and perceptions regarding GE（Q6）are shown in Table 3. Pharmacists who received education during their pharmacy career were significantly more likely than those who received no education at all to respond positively to（category number: 14）"I have a general understanding of GE." and（15）"I would actively recommend the use of GE to my patients"（P<0.01; ① vs. ②）.

Pharmacists who received education as pharmacy students were significantly more likely than those who received no education at all to declare knowledge of（3）bioequivalence（P<0.01）,（4）dosage form（P=0.02）,（11）generic name and therapeutic area,（13）and advantages of GE（P<0.01）, in addition to respond positively to（15）"I would actively recommend the use of GE to my

Q5 : Bioequivalence implies that the 90% confidence interval for the ratio of AUC (area under the plasma drug concentration) and Cmax of the generic medicine to those of the brand name medicine is within a certain tolerance range. Please select the applicable range.
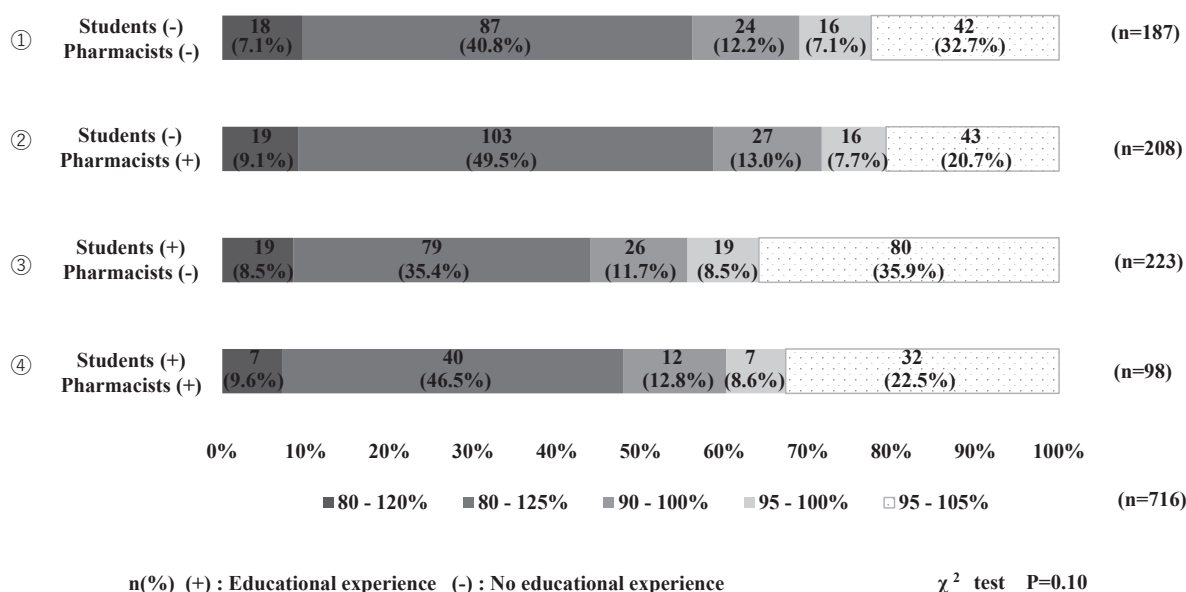

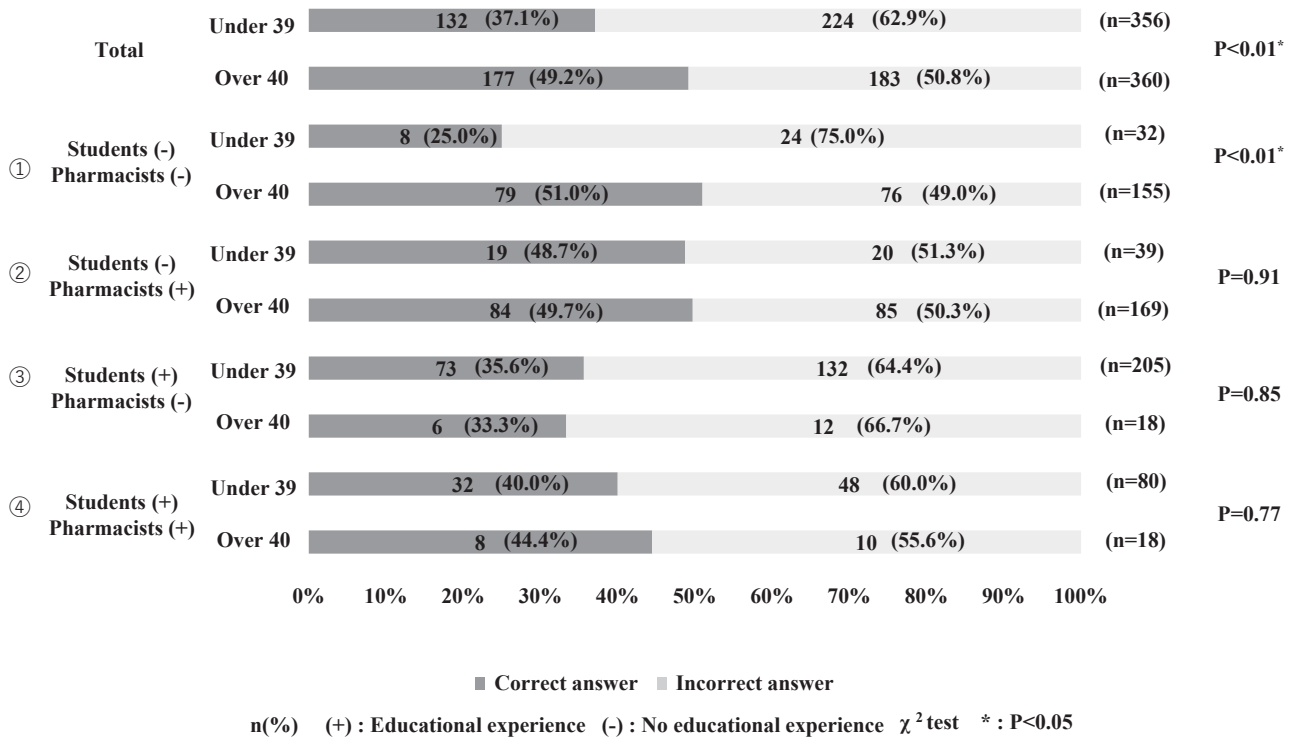Figure 1　Recognition of bioequivalence

n(%)　　(+) : Educational experience　(-) : No educational experience　χ^2 test　* : P<0.05

Figure 2　Percentage of correct answers to Q5 among pharmacists in two age groups（under 39 years and over 40 years）

Table 3　Knowledge and perceptions about generic medicines

Q6	① Students (-) Pharmacists (-) (n = 203)	② Students (-) Pharmacists (+) (n =264)	③ Students (+) Pharmacists (-) (n = 230)	④ Students (+) Pharmacists (+) (n = 108)	P-value ①vs.②	P-value ①vs.③	P-value ①vs.④
1) All generic medicines evaluated as equivalent to a particular brand-name medicine are bioequivalent to the brand-name medicine	3.2 ± 1.0	3.3 ± 1.0	3.4 ± 1.0	3.4 ± 1.2	0.73	0.08	0.09
2) All generic medicines evaluated as equivalent to a particular brand-name medicine are bioequivalent to each other	2.6 ± 0.9	2.8 ± 1.0	2.7 ± 1.1	2.8 ± 1.2	0.35	0.97	0.57
3) Generic medicines are bioequivalent to brand-name medicines	3.2 ± 0.9	3.1 ± 1.0	3.6 ± 1.0	3.5 ± 1.1	0.96	<0.01*	0.09
4) A generic medicine must be in the same dosage form (e.g., tablet, capsule) as the brand-name medicine	2.2 ± 1.0	2.2 ± 1.1	1.9 ± 0.9	2.1 ± 1.2	0.99	0.02*	0.56
5) A generic medicine must contain the same dose as the brand-name medicine	4.0 ± 1.0	4.0 ± 1.1	3.8 ± 1.2	3.9 ± 1.3	0.99	0.28	0.96
6) Generic medicines are inferior in quality than brand-name medicines	2.5 ± 1.0	2.5 ± 0.9	2.1 ± 0.8	2.2 ± 1.0	0.98	<0.01*	0.04*
7) Generic medicines are less effective than brand-name medicines	2.3 ± 0.8	2.3 ± 0.8	2.0 ± 0.8	2.0 ± 0.8	0.99	<0.01*	0.04*
8) Generic medicines produce more side effects than brand-name medicines	2.3 ± 0.8	2.3 ± 0.8	2.1 ± 0.8	2.0 ± 0.8	0.65	0.26	0.15
9) Generic medicines are less expensive than brand-name medicines	4.2 ± 0.9	4.3 ± 0.7	4.3 ± 0.8	4.3 ± 0.8	0.90	0.38	0.79
10) Brand-name medicines are required to meet higher safety standards than generic medicines	2.9 ± 1.1	3.0 ± 1.1	2.8 ± 1.0	2.8 ± 1.2	0.69	0.94	0.89
11) I find it easier to recall a medicine's therapeutic class using generic names rather than brand names	3.3 ± 1.1	3.3 ± 1.0	4.2 ± 0.9	3.9 ± 1.0	0.99	<001*	<0.01*
12) The use of generic medicines can reduce national health care costs	4.2 ± 0.9	4.2 ± 0.8	4.4 ± 0.7	4.4 ± 0.8	0.91	0.12	0.06
13) Some generic medicines have advantages (e.g., better dosing feel and easier administration) that brand-name medicines do not have	4.0 ± 0.8	4.0 ± 0.8	4.3 ± 0.6	4.4 ± 0.6	0.94	<0.01*	<0.01*
14) I have a general understanding of generic medicines	3.2 ± 0.9	3.5 ± 0.8	3.1 ± 0.8	3.3 ± 0.8	<0.01*	0.51	0.80
15) I would actively recommend the use of generic medicines to my patients	3.6 ± 0.8	3.8 ± 0.8	3.9 ± 0.7	3.8 ± 0.8	<0.01*	0.03*	0.04*
16) If I become a patient, I want to actively use generic medicines	3.5 ± 1.0	3.6 ± 1.0	4.0 ± 0.8	4.0 ± 1.0	0.37	<0.01*	<0.01*
17) I need more information on how bioequivalence studies are conducted for generic medicines	3.4 ± 1.0	3.3 ± 0.9	3.5 ± 0.9	3.4 ± 1.0	0.99	0.54	0.92
18) I need more information on the issues pertaining to the safety and efficacy of generic medicines	3.4 ± 1.0	3.4 ± 0.9	3.6 ± 0.9	3.5 ± 1.0	0.99	0.36	0.66

(+) : Educational Experience　　　(-) : No Educational Experience　　Mean ± S.D.　　Steel test　* : P<0.05

For Q6 items 1, 3, 5, 9, and 11-18, the higher the means, the more the appropriate knowledge and perceptions.
For Q6 items 2, 4, 6-8, and 10, the lower the means, the more the appropriate knowledge and perceptions.

patients." （P=0.03）and（16）"If I become a patient, I want to actively use GE."（P<0.01）. They also had significantly lower negative perceptions toward（6）quality and（7）effectiveness of GE(P<0.01; ① vs. ③).

Pharmacists who received education both as students and as pharmacists had significantly less negative attitudes toward the（6）quality and（7）efficacy of GE than pharmacists who received no education at all（P=0.04）. In addition, they were significantly more likely to declare an understanding of（11）generic name and medicine's therapeutic class, and（13）the advantages of GE （P<0.01）, as well as to respond positively to（15）"I would actively recommend the use of GE to my patients."（P=0.04）, and（16）"If I were a patient, I would be willing to use GE."（P<0.01; ① vs. ④）.

Table 4 presents the results of comparison of the differences in knowledge and perceptions of GE between the groups of pharmacists（those

under 39 years of age and those over 40 years of age）. The results indicated that regardless of educational experience as a pharmacy student or as a pharmacist, pharmacists aged over 40 years had lower knowledge and perceptions of GE than pharmacists aged under 39 years. In addition, regardless of educational experience, pharmacists aged over 40 years had significantly higher negative perceptions of GE（6）quality,（7）efficacy, and（8）side effects than pharmacists aged under 39 years （P<0.01）（groups ①, ③, and ④）.

5. Topics individuals would like to be educated on regarding GE in future

In the descriptive survey on what type of education the individuals would like to receive regarding GE in the future（Q7）, the most common answer was "GE with differences in indications, taste, and usability impression," followed by

Table 4　Comparison of knowledge and perceptions about generic medicines among pharmacists in two age groups（under 39 years and over 40 years）

Q6	Total			① Students (-) Pharmacists (-)			② Students (-) Pharmacists (+)			③ Students (+) Pharmacists (-)			④ Students (+) Pharmacists (+)		
	Under 39 (n=372)	Over 40 (n=433)	P-value	Under 39 (n=33)	Over 40 (n=170)	P-value	Under 39 (n=44)	Over 40 (n=220)	P-value	Under 39 (n=210)	Over 40 (n=20)	P-value	Under 39 (n=85)	Over 40 (n=23)	P-value
1)	3.4 ± 1.0	3.2 ± 1.0	<0.01*	3.3 ± 1.1	3.1 ± 1.0	0.33	3.2 ± 1.1	3.3 ± 1.0	0.88	3.4 ± 1.0	3.6 ± 0.9	0.41	3.6 ± 1.1	2.8 ± 1.2	<0.01*
2)	2.8 ± 1.1	2.7 ± 1.0	0.27	2.8 ± 1.0	2.6 ± 0.9	0.20	2.8 ± 1.0	2.8 ± 1.0	0.87	2.7 ± 1.1	2.9 ± 0.9	0.24	3.0 ± 1.2	2.0 ± 0.8	<0.01*
3)	3.6 ± 1.0	3.1 ± 1.0	<0.01*	3.6 ± 0.9	3.1 ± 0.9	<0.01*	3.2 ± 0.9	3.1 ± 1.0	0.61	3.7 ± 1.0	3.4 ± 1.1	0.24	3.6 ± 1.0	3.0 ± 1.3	0.06
4)	2.0 ± 1.1	2.2 ± 1.0	<0.01*	2.0 ± 1.1	2.2 ± 1.0	0.17	1.9 ± 1.1	2.2 ± 1.0	<0.01*	1.9 ± 1.0	1.8 ± 0.4	0.85	2.1 ± 1.3	2.2 ± 0.9	0.26
5)	3.8 ± 1.2	4.0 ± 1.1	0.02*	3.9 ± 1.0	4.0 ± 1.1	0.53	3.9 ± 1.2	4.0 ± 1.1	0.63	3.8 ± 1.2	3.9 ± 1.2	0.79	3.8 ± 1.3	4.2 ± 1.0	0.13
6)	2.1 ± 0.9	2.5 ± 0.9	<0.01*	2.1 ± 0.9	2.6 ± 0.9	0.01*	2.3 ± 1.0	2.5 ± 0.8	0.18	2.1 ± 0.8	2.7 ± 0.9	<0.01*	2.1 ± 1.0	2.6 ± 0.7	<0.01*
7)	2.0 ± 0.8	2.4 ± 0.8	<0.01*	1.9 ± 0.8	2.4 ± 0.8	<0.01*	2.1 ± 0.8	2.4 ± 0.8	0.17	2.0 ± 0.8	2.3 ± 0.9	0.02*	1.9 ± 0.8	2.6 ± 0.7	<0.01*
8)	2.0 ± 0.8	2.4 ± 0.8	<0.01*	1.8 ± 0.9	2.3 ± 0.8	<0.01*	2.3 ± 1.0	2.4 ± 0.8	0.68	2.1 ± 0.8	2.4 ± 0.9	<0.01*	1.9 ± 0.8	2.6 ± 0.7	<0.01*
9)	4.3 ± 0.8	4.2 ± 0.8	0.27	4.2 ± 0.7	4.2 ± 0.9	0.63	4.4 ± 0.7	4.2 ± 0.7	0.19	4.3 ± 0.8	4.5 ± 0.6	0.56	4.3 ± 0.7	4.3 ± 0.8	0.64
10)	2.8 ± 1.1	2.9 ± 1.1	0.28	2.8 ± 1.3	2.9 ± 1.1	0.65	3.2 ± 1.2	2.9 ± 1.1	0.07	2.8 ± 1.0	2.8 ± 1.2	0.87	2.7 ± 1.2	3.0 ± 1.0	0.62
11)	4.1 ± 1.0	3.2 ± 1.0	<0.01*	3.8 ± 1.1	3.2 ± 1.0	<0.01*	3.8 ± 1.0	3.2 ± 1.0	<0.01*	4.2 ± 0.9	3.7 ± 1.2	0.03*	4.0 ± 1.0	3.3 ± 1.0	<0.01*
12)	4.4 ± 0.8	4.2 ± 0.9	<0.01*	4.2 ± 1.0	4.1 ± 0.9	0.26	4.5 ± 0.7	4.2 ± 0.9	0.03*	4.4 ± 0.7	4.2 ± 0.9	0.20	4.4 ± 0.8	4.6 ± 0.5	0.51
13)	4.3 ± 0.6	4.0 ± 0.8	<0.01*	4.2 ± 0.6	4.0 ± 0.8	0.02*	4.3 ± 0.6	3.9 ± 0.8	<0.01*	4.2 ± 0.7	4.4 ± 0.5	0.37	4.4 ± 0.7	4.1 ± 0.5	0.02*
14)	3.2 ± 0.8	3.4 ± 0.8	0.02*	3.3 ± 0.9	3.2 ± 0.9	0.99	3.5 ± 0.8	3.5 ± 0.7	0.95	3.1 ± 0.8	3.1 ± 0.9	0.91	3.4 ± 0.8	3.3 ± 0.7	0.58
15)	3.9 ± 0.8	3.7 ± 0.8	<0.01*	3.9 ± 0.9	3.5 ± 0.8	0.01	4.0 ± 0.7	3.8 ± 0.8	0.13	3.9 ± 0.7	3.9 ± 0.8	0.98	3.9 ± 0.8	3.7 ± 0.7	0.08
16)	4.0 ± 0.9	3.5 ± 1.0	<0.01*	4.0 ± 1.0	3.4 ± 1.0	<0.01*	3.9 ± 0.9	3.6 ± 1.0	0.03*	4.1 ± 0.8	3.8 ± 1.1	0.33	4.1 ± 1.0	3.7 ± 0.9	0.24
17)	3.4 ± 1.0	3.4 ± 0.9	0.18	3.5 ± 1.1	3.3 ± 1.0	0.33	3.3 ± 1.0	3.3 ± 0.9	0.99	3.5 ± 0.9	3.6 ± 1.2	0.48	3.4 ± 1.1	3.5 ± 0.8	0.81
18)	3.5 ± 0.9	3.4 ± 0.9	0.22	3.5 ± 1.1	3.4 ± 1.0	0.33	3.5 ± 1.0	3.4 ± 0.9	0.92	3.6 ± 0.9	3.6 ± 1.2	0.47	3.5 ± 1.0	3.6 ± 0.8	0.71

Mean ± S.D.　Mann - Whitney U test　*P < 0.05
For Q6 items 1, 3, 5, 9, and 11-18, the higher the means, the more appropriate the knowledge and perceptions.
For Q6 items 2, 4, 6-8, and 10, the lower the means, the more appropriate the knowledge and perceptions.

"sources and quality of bulk drug substance" and "cases in which GE use results in differences in efficacy and side effects"（data not shown）.

Discussion

Pharmacists employed in insurance pharmacies and hospitals were surveyed to explore their educational experiences with regard to GE topics during their pharmacy school years and after commencing their careers as pharmacists. The aim of the study was to compare the knowledge and perceptions of GE between pharmacists who received education on the subject and those who did not.

The results of the survey showed that less than 50% of the pharmacists had received education on GE, as not only a pharmacy student but also a pharmacist, indicating that many pharmacists had no opportunity to receive education on GE. Therefore, it is considered necessary to increase the number of learning opportunities to raise the perceptions of appropriate understanding and promotion of GE use in the future. In addition to "advantages of GE" and "medical fee system related to GE," which received few responses in the survey on the content of education received as a pharmacy student, "interpretation of bioequivalence study results"[9], which received a low percentage of correct responses regardless of educational experience, needs to be included as a specific learning contents that are necessary in future. Although the current Model Core Curriculum for Pharmacy Education（revised in 2013）[10] does not clearly state the contents of the "advantages of GE," "medical fee system regarding GE," and "interpretation of bioequivalence study results," it is anticipated that all pharmacy colleges will provide education during lectures and practical training. Furthermore, it is expected that education on GE will be improved even when based on the Model Core Curriculum for Pharmacy Education（revised in 2022）[11]. Conversely, those who received education on GE after becoming pharmacists had learned basic content about GE, such as bioequivalence, quality, and economic benefits, suggesting that they had the opportunity to learn about general contents. In addition, the results of the Q7 on issues

they would like to know more about GE in future showed that the main issues cited were "Sources and quality of active pharmaceutical ingredients," "Cases of differences in efficacy and side effects due to GE use," and "GE with different indications, taste, and feel," which interfere with daily clinical operations. This is because approximately 60% of the active pharmaceutical ingredients in Japan are procured from overseas suppliers[7] and the respondents feel unsafe about the quality of the active pharmaceutical ingredients. Moreover, there is a lack of understanding of specific reasons for the differences in the usability of oral and topical medications among GE.

The percentage of correct responses to the "Acceptable range of 90% confidence interval for the ratio of blood concentration of brand-name medicines to that of GE in bioequivalence studies"（Q5）was low, ranging from 35% to 50%, regardless of whether the respondents had been educated on bioequivalence studies as a pharmacy student or as a pharmacist（Figure 1）. This indicates that many pharmacists do not have adequate knowledge of bioequivalence studies. Surveys of Palestinian and U.S. pharmacists reported low percentages of correct responses（12.6% and 7.3%, respectively）[12, 13], suggesting that this theory may be challenging to understand and retain, and that further education is necessary. A previous survey of pharmacy students in a 6-year program found that less than 5% of them understood the interpretation of bioequivalence study results[8]. A similar aspect could be attributed for the lower percentage of correct responses among individuals under 39 years of age than among those over 40 years of age. The results of this survey also indicated that there was no impact of education on pharmacy students. Knowledge of bioequivalence test needs to be improved, regardless of educational experience and age.

The results regarding knowledge and perceptions of GE in Q6 showed that pharmacists who were educated about GE had significantly lower negative perceptions of GE in terms of "inferior quality" and "low efficacy" than those who were not educated at all. These pharmacists had significantly higher perceptions of generic names, therapeutic areas

and advantages of GE, and they would actively recommend GE to patients and they themselves would actively use GE if required（ ① vs. ④ ）. These observations suggest that pharmacists who have received education on GE will have a more appropriate understanding of GE than pharmacists who did not receive such education, leading to greater promotion of GE use. A survey of Chinese pharmacists reported a significant positive correlation between knowledge and perceptions of GE use[14]. Similar findings were obtained in the present study.

Pharmacists who received education on GE only as a student had considerably higher knowledge of bioequivalence and dosage forms than those who received no education at all（ ① vs. ③ ）. The results suggest that pharmacists should be engaged in pharmacy practice after ensuring that they have a basic understanding and knowledge on GE through undergraduate education. In addition, the group that received education as students had significantly higher knowledge and perceptions of quality, efficacy, generic names, therapeutic areas, and added value of GE, and these pharmacists themselves would actively use GE if required. This may be because the students were engaged as pharmacists with improved knowledge and perceptions on the quality of GE and promotion of GE use because of lectures on GE at undergraduate school and practical training experience.

Compared with the perceptions of pharmacists who received no education on GE at all, those who received education on GE only during their pharmacy career were significantly more likely to respond positively to "I understand GE in general" and "I would actively recommend GE use to my patients;" however, there was no difference in knowledge content（ ① vs. ② ）. In particular, education as a student had a stronger influence on the improvement of knowledge and perceptions of GE than education as a pharmacist. It was suggested that undergraduate education might influence the improvement of perceptions of appropriate GE use after working as a pharmacist. The reason for the better knowledge and perceptions among pharmacists was that they learned basic knowledge and universal rules of GE in their undergraduate

education; therefore, they started clinical practice without any concerns or distrust regarding the quality and efficacy of GE. Therefore, they did not have a negative attitude toward GE use even when they experienced real cases in clinical practice where there were differences in quality and efficacy. However, pharmacists who did not receive undergraduate education were more likely to have a negative attitude toward GE use when they experienced cases of differences in quality and efficacy in the clinical setting. Although not shown in the results, there was a notable difference between pharmacists working in hospitals and those in pharmacies in terms of their perceptions of "I would actively recommend GE use to my patients." Pharmacy pharmacists had a significantly higher inclination towards this recommendation than hospital pharmacists（data not shown）. This could be attributed to hospital pharmacists having limited opportunities to recommend the use of GE to their patients, as they primarily work with medications prescribed by the hospital. However, pharmacy pharmacists have more opportunities to actively recommend the use of GE to their patients, depending on whether or not they use GE.

The fact that individuals under 39 years of age demonstrated higher knowledge and perceptions on many items than those over 40 years of age suggests that the need to provide educational opportunities in the future, especially for pharmacists over 40 years of age. In particular, the low perceptions of GE quality, efficacy, and side effects may be because pharmacists in their over 40 years of age had less educational experience as pharmacy students, an issue that needs to be resolved in future.

At the time of this survey in 2019, there were scattered cases of supply instability for some GE. Recently, there has been a shortage of GE products as a result of the disclosure of irregularities in drug manufacturing processes and quality control by GE manufacturing companies. This has led to the suspension of operations of several pharmaceutical companies. In order to address this issue, the Ministry of Health, Labour and Welfare has advised that pharmaceutical companies should disclose information on the stable supply of GE and

implement measures to improve the production efficiency of GE[15]. It is believed that establishing a system to ensure a steady supply of GE in the future could further enhance awareness and promote its use.

A limitation of this study is that it covered only insurance and hospital pharmacists in a single prefecture and did not reflect the opinion of insurance pharmacies and hospital pharmacists, such as those working in medical institutions in other prefectures or pharmacists working in drugstores. Moreover, the survey did not examine whether pharmacists attended a 4-year or 6-year program, and this difference may result in variations in the content of GE education, recognition, and perceptions. This is a limitation of the study, and we believe that expanding the survey scope in the future would provide further clarification on the status of pharmacists' education regarding GE and future educational issue. An Ethiopian pharmacist reported that gender difference was substantially associated with the perceptions of GE use[16]. Our survey did not include a gender question; hence a comparison could not be made.

The results of this survey indicated that pharmacists have limited education experience about GE and that education improves their knowledge of GE and their perceptions with regard to promotion of its use. In particular, the presence or absence of education as a student considerably affected appropriate knowledge about GE and perceptions of promoting its use, suggesting that the experience of undergraduate education would positively affect pharmacists' perceptions of the proper use of GE after becoming pharmacists. On the contrary, the results suggest that pharmacists over 40 years of age who have no experience in pharmacy education need more education on GE in the future. In future, it is important for pharmacists to learn about GE to improve their knowledge and perceptions of GE to consult their patients when using GE and to provide appropriate information to physicians when prescribing GE.

Acknowledgments

Conflict of Interest

There are no conflicts of interest to report.

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