




The Impact of COVID-19 on Education: A Cross-Sectional Study of Distance Learning among Medical Students

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Abstract

Background: The COVID-19 pandemic affected educational institutions and caused the transfer to distance learning. The study aimed to assess medical students' satisfaction with synchronous distance learning (SDL) during the pandemic and predict their choice of it in the future.

Methods: A cross-sectional study was conducted among undergraduate medical students at the Al-Farabi Kazakh National University in July 2021. An online questionnaire was used to collect data on demographic and educational characteristics, satisfaction, and perspective on the future choice of SDL. IBM SPSS Statistics, version 26, was used to analyze the qualitative data on descriptive and inferential statistics.

Results: Students' satisfaction and future choice of SDL were 43.2% and 20.2%, respectively. Regression analysis revealed the significance of SDL predictors with a direct relationship in the case of gender and academic performance and predictors with an inverse relationship in the case of residency, student life satisfaction, and SDL with student satisfaction. In the predictive model, student satisfaction and probability of future choice of SDL over traditional learning were 59.5% and 43.5%, respectively; over hybrid learning, it was 20.2% of students.

Conclusion: The research findings suggested that slightly less than half of the respondent medical students were satisfied by distance learning during the COVID-19 pandemic when their satisfaction probability was significantly higher in the predictive model. The predictive model of perspective of choice of distance learning did not show statistically significant results compared with traditional and hybrid learning.

Keywords: COVID-19, Synchronous Distance Learning, Satisfaction, Predictive Model, Medical Students, Academic Performance

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Introduction

The COVID-19 pandemic affected the population worldwide, causing 761.0 million cases and killing 6.9 million people worldwide from 2019 to 2023, with 1.4 million cases and 18 thousand deaths in Kazakhstan (1). In addition

to the direct impact on human life, the COVID-19 pandemic has affected all aspects of human life, including the educational system. Since the WHO announced the pandemic on January 30, 2020, Educational Institutions, including those in Kazakhstan, have switched to non-contact

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↑What is “already known” in this topic:

It is known that during COVID-19, many countries implemented online learning for undergraduate and graduate students to prevent this infection and disease. Many publications assessed and positively evaluated the effectiveness despite distance learning issues.

→What this article adds:

This article increases the experience of synchronous distance learning of medical students in Kazakhstan during the pandemic in different countries. It determined that the positive students' perception was less than half of them, although their self-assessment of academic performance was assessed higher.

learning for schoolchildren and students worldwide. They examined publications on the study of e-learning and distance learning students during the pandemic (2-22, 23). E-learning uses electronic media and devices to enhance learning, communication, and interaction assessment. Distance learning (DL) can be synchronous and asynchronous depending on the synchronization of receiving and sending information between training participants. If asynchronous learning involves delayed receipt of data, the synchronous format means real-time interaction between students and teachers. Students and university professors of High Educational Institutions have a mixed assessment of distance learning in various educational areas (5); the same trend was noted in the case of medical students (6). Since the WHO announced the threat of coronavirus infection, curricula and training strategies of synchronous distance learning (SDL) have been prepared at the Al-Farabi Kazakh National University. 25 000 undergraduate, graduate, and doctoral students of 16 faculties of the University, including the Faculty of Medicine and Healthcare, conducted the SDL from March 2019 to March 2021 using computer-based education programs such as Zoom, Microsoft Teams, Google Meets, Classroom, Univer, and Skype.

The study aimed to assess medical students' satisfaction with synchronous distance learning (SDL) during the pandemic and predict their choice of it in the future. The research questions were: 1) What percentages of students are satisfied with the SDL? 2) What are the prospects of distance learning according to students' opinions? The null hypothesis (H_0) for the first and second research questions was no differences in assessing students' perception and future choice of SDL; the alternative hypothesis (H_a) was to identify discrepancies.

Al-Farabi Kazakh National University switched to online learning in March 2019. Various electronic and educational systems, Moodle, Zoom, Microsoft Teams, Meets, and Classroom, and the basic electronic information and educational design "UNIVER" used, were introduced to teach undergraduate, graduate, and doctoral students from 16 faculties in a distance learning mode.

Methods

Study Design

We conducted a cross-sectional study among Faculty of Medicine and Healthcare students using a self-administered questionnaire shared online in students' sites and communities. Completed questionnaires were saved in the Excel program. After review and completeness of filling, 514 questionnaires that met the inclusion conditions were selected and imported to the SPSS program. In the next stage, the questionnaires of graduate students were excluded to evaluate the tasks, which differed in the complexity of the educational program and insufficient samples from the undergraduate students. The remaining 484 questionnaires of undergraduate students were entered into the SPSS program for statistical analysis.

Data Collection

We created an online questionnaire with 34 – items in

Google documents in Kazakh, Russian, and English languages relating to their characteristics (gender, country of residence, specialty of an educational program, year of study, language of training, part-day work) and satisfaction with the SDL (general, process, technical issues, faculty staff activity) and Students' preference of DL compared with traditional (TL) and hybrid learning (HL). The inclusion criteria were undergraduate study at the Faculty of Medicine and Healthcare, willingness to participate in the survey, and anonymity; the exclusion criterion was incomplete data. We got 514 questionnaires but used 484 meeting the inclusion conditions, which were imported into the SPSS program for statistical analysis.

Statistical Analysis

Qualitative data on participants' characteristics and estimated study outcomes, such as students' satisfaction and the choice of DL in the future, were analyzed. They were binary (yes or no) and multiplied variables in the analysis using the Chi-square test and regression model. A binary logistic regression used the inverse Wald step to identify the dependence of outcome probability (satisfaction with SDL and its future choice) on categorical variables as the influence factors. A predictive model (P) was calculated on the formula: $P = 1 / (1 + e^{-z}) * 100\%$ for the prognosis of students' satisfaction and DL choice in the future compared with TL and HL. Differences were considered significant if $P < 0.05$. The study results were analyzed using IBM SPSS Statistics software, version 26.0.

Results

Baseline and Demographic Characteristics

We enrolled 484 participants in the analysis. Distribution of participants revealed a slight prevailing of male participants (51.7%) and non-residents (54.8%) on demographic and personal characteristics; more prevailing of general medicine students (74.0%) and 1-2 years students (89.9%) on a specialty (Table 1). Less than ½ of students were generally satisfied with distance learning, while more than ½ were satisfied with the learning process. Only 33.5% of students talked about technical problems affecting learning related to internet quality, technological devices, and user skills. A significant majority of the participants were satisfied with the activities of the teaching staff in the SDL mode (88.0%).

Assessment of participants' satisfaction with distance learning in general and in stratified groups

The proportion of students who were satisfied with the SDL was 43.2% overall (95% CI 38.7-47.7%) vs. those who were dissatisfied - 56.8% (95% CI 52.3-61.3%). Statistically significant differences were obtained when comparing the frequency of satisfied and dissatisfied students with SDL depending on the predictors grouped by the presence of strength of association by Pearson Chi-square test: like a study in the SDL" ($\chi^2=178.948, P \leq 0.001$), satisfaction by AP ($\chi^2 = 95.920, P \leq 0.001$) and country of residence ($\chi^2 = 82.642, P \leq 0.001$). Statistically significant differences with average strength were determined when com-

Table 1. Demographic and educational characteristics of participants

Participants' characteristics, n=484		N	%
Gender	Male	250	51.7
	Female	234	48.3
Country of residence	Resident	219	45.2
	Non-resident	265	54.8
A specialty of an educational program	Public Health	117	24.2
	HealthhealthОбщественное Здравоохранение		
	General Medicine	321	66.3
	Dentistry	9	1.9
	Physical Culture and Sport	11	2.3
Year of Study	1-2 years	435	89.9
	3-4 years	49	10.1
Training language	English language	239	49.4
	Kazakh language	183	37.8
	Russian language	62	12.8
Part-day work	Yes	269	55.6
	No	215	44.4
Student Life Satisfaction (SLS)	Yes	242	50.00
	No	204	42.1
	Neutral	38	7.9
Satisfaction with Academic Performance (AP)	Satisfied	295	61.0
	Unsatisfied	189	39.0
Satisfaction with the SDL (general)	Unsatisfied	275	56.8
	Satisfied	209	43.2
Satisfaction with the SDL (process)	Unsatisfied	199	41.1
	Satisfied	285	58.9
Satisfaction with the SDL (technical issues)	Unsatisfied	162	33.5
	Satisfied	322	66.5
Satisfaction with the SDL (faculty staff activity)	Unsatisfied	58	12.0
	Satisfied	426	88.0
Satisfaction with the SDL (academic performance)	Unsatisfied	275	56.8
	satisfied	209	43.2
Student preference	Traditional learning	206	42.6
	Distance learning	91	18.8
	Hybrid learning	171	38.6

paring satisfied and dissatisfied students depending on predictors such as a specialty of an educational program ($\chi^2 = 57.527$, $P \leq 0.001$), learning languages ($\chi^2 = 94.561$, $P \leq 0.001$) and evaluation of "faculty staff activities" ($\chi^2 = 23.735$, $P \leq 0.001$) (Table 2).

In regression analysis, there was a direct relationship between SDL students' satisfaction with gender ($P = 0.004$) and satisfaction with academic performance ($P \leq 0.001$) by adjusted OR 95% CI; and an inverse relationship between SDL students' satisfaction with being a resident ($P \leq 0.001$), student life satisfaction ($P = 0.016$), satisfaction with academic performance ($P \leq 0.001$), liking to study at SDL ($P \leq 0.001$), Table 3.

A regression analysis of satisfaction with SDL (process, technical aspects, and faculty staff activities) depended on predictors. When assessing the process of satisfaction with the SDL, it determined a direct relationship with the predictor "assessment of Faculty staff activity" (2.506 (1.333; 4.711)) and "satisfaction of the academic performance" (7.488(4.896;11.452)); and an inverse relationship was determined with "a country of residence" (0.171(0.115;0.253) and "student's life satisfaction" (0.581(0.405-0.834)) predictors.

A direct relationship was revealed between "the satisfaction of SDL" (the technical aspects) and: "years of study" (2.809(1.284;6.143)), "satisfaction with AP" (2.103(95% CI 1.399;3.163)), and "student's life" (1.867 (95% CI 1.273;2.739)) predictors. It determined the inverse relation

between the variable "satisfaction with SDL and predictors such as "country of residence" (0.195(0.129;0.294))*and "faculty staff activity" (0.376 (0.185;0.764)) . An assessment of "satisfaction with the SDL" (the assessment of faculty staff activities) revealed direct relationship with predictor country of residence (2.390 (1.303;4.382)); and an inverse relationship with the year of learning (and (satisfaction with academic performance (0.148 (0.077;0.282)), Table 4.

A predictive model to determine the probability of student satisfaction with SDL was developed using a method of binary logistic regression. Adjusted odds ratio (AOR) and binary categorical variables such as gender, country of residence, year of study (1-2 versus 3-4 years), part-time work, like SDL, satisfaction with SL, faculty staff activity, and AP were used in this model. The inverse Wald step was used in the analysis. The observed dependence was described by equation (P1) and equals 8.82%.

$$P = 1 / (1 + e^{-z}) * 100\% = 1 / (1 +) * 100\% = 8.82\%.$$

$$Z = 0.747 + 1.452 * X_{\text{satisfAP}} + 0.769 * X_{\text{sex}} + (-1.086) * X_{\text{satisfSL}} + (-2.661) * X_{\text{likeSDL}} + (-1.051) * X_{\text{countryResid}};$$

$$Z = 0.747 + (1.452 * 1) + (0.769 * 1) + (-1.086 * 0) + (-2.661 * 0) + (-1.051 * 0) = 2.97;$$

Where P—probability of student satisfaction with the SDL(%), X_{satisfAP} (1=yes, 0=no), X_{sex} (0=female, 1=male), X_{satisfSL} (0=no, 1=yes), X_{likeSDL} (0=no, 1=yes), $X_{\text{countryResid}}$ (0=non-resident, 1=resident).

Table 2. Distribution of students according to their level of satisfaction with the SDL (χ^2 criterion)

variable		Total (n, %)	Satisfaction of SDL		Statistics χ^2 , P-value, v Cramer
			(Yes)	(No)	
Sex	Male	250 (51.7)	105 (42.0)	145 (58.0)	$\chi^2 = 10.044^a$ $p=0.002$ $v = 0.144$
	Female	234 (48.3)	132 (56.4)	102 (43.6)	
Country of residence	Resident	219 (45.2)	57 (71.7)	62 (28.3)	$\chi^2 = 82.642^a$ $p \leq 0.001$ $v = 0.413$
	Non-resident	265 (54.8)	80 (30.2)	185 (69.8)	
A specialty of an educational program	Public Health	117(24.2)	74 (62.2)	24 (20.2)	$\chi^2 = 57.527^a$ $p \leq 0.001$ $v = 0.385$
	General Medicine	321(66.3)	90 (30.5)	159 (53.9)	
	Dentistry	9 (1.9)	3 (36.5)	3 (37.5)	
	Physical Culture and Sport	11(2.3)	12 (80.0)	2 (13.3)	
Years of study	1-2 years	435 (89.9)	219 (50.3)	216 (49.7)	$\chi^2 = 3.264^a$ $p=0.071$ $v = 0.082$
	3-4 years	49 (10.1)	18 (36.7)	31 (63.23)	
Learning language	English	239 (49.4)	64 (26.8)	175 (73.2)	$\chi^2 = 94.561^a$ $p \leq 0.001$ $v = 0.365$
	Kazakh	183 (37.8)	125 (68.3)	58 (31.7)	
	Russian	62 (12.8)	48 (77.4)	14 (22.6)	
Have part-day work	Yes	269 (55.6)	126 (46.8)	143 (53.2)	$\chi^2 = 1.096^a$ $p=0.295$ $v = 0.048$
	No	215 (44.4)	111 (51.6)	104 (48.4)	
Like learning in the SDL	Yes	203 (49.1)	172 (84.7)	31 (15.3)	$\chi^2 = 178.948^a$ $p \leq 0.001$ $v = 0.608$
	No	281 (50.9)	65 (23.1)	216(76.9)	
Assessment of faculty staff activity	Satisfied	426 (88.0)	226 (53.1)	200 (46.9)	$\chi^2 = 23.735^a$ $p \leq 0.001$ $v = 0.221$
	Unsatisfied	58 (12.0)	11 (19.0)	47 (81.0)	
Students' Life satisfaction	Satisfied	261(53.9)	144 (55.2)	117(44.8)	$\chi^2 = 12.613^a$ $p=0.003$ $v = 0.161$
	Unsatisfied	223 (46.1)	93(41.7)	130(58.3)	
Satisfaction with Academic Performance (AP)	Yes	295 (61.0)	197 (66.8)	98 (33.2)	$\chi^2 = 95.920^a$ $p \leq 0.001$ $v = 0.445$
	No	189 (39.0)	40 (21.2)	149 (78.8)	
Perspective type of learning	Traditional	206 (42.6)	87 (42.2)	119 (57.8)	$\chi^2 = 29.859^a$ $p \leq 0.001$ $v = 0.248$
	Distant	91 (18.8)	68 (74.7)	23 (25.3)	
	Hybrid	187 (38.6)	82 (43.9)	105 (56.1)	
Preference of DL to TL	Yes	91 (30.6)	68 (74.7)	23 (25.3)	$\chi^2 = 26.706^a$ $p \leq 0.001$ $v = 0.300$
	No	206 (69.4)	87 (42.2)	119 (5.8)	
Preference of DL to HL	Yes	91 (32.7)	68 (74.7)	23 (25.3)	$\chi^2 = 23.488^a$ $p \leq 0.001$ $v = 0.291$
	No	18 67.3)	82 (43.9)	105 (56.91)	

The obtained regression model was statistically significant ($P < 0.001$). Based on the value of the Nigelerk determination coefficient, model 1 determines 59.5% of the variance of the probability of perception of satisfaction with the SDL by the FMPH's students. The variance of the probability of detecting students' satisfaction with the SDL was determined by the factors included in model 1, based on the regression coefficients' values, gender, and the satisfaction of AP directly correlated with satisfaction with the SDL. Predictors as a country of residence, satisfaction with SL, and performance appraisal of the faculty staff were inversely related to the probability of a satisfactory evaluation of the SDL. The characteristics of the factors are presented in Table 4. The threshold value of the predictive model (P1) was 59.5%, which showed a positive probability of student satisfaction with distance learning. The sensitivity and specificity of the model at the threshold value were 76.8% and 87.4%, respectively.

Assessment of Students' future choice for c distance learning

Most students chose TL in contrast to DL and HL (42.6%, 18.8%, and 38.6%, respectively), Table 2. Using binary logistic regression, we developed a predictive model to determine the probability of students' preference for DL

vs. TL in the future depending on various factors. Regression analysis revealed a statistically significant inverse relationship between predictors "satisfaction of SDL"(COR 0.247 95% (0.143-0.428), $P \leq 0.001$) and "satisfaction of Academic Performance" (COR 0.351;95% CI 0.200-0.613, $P \leq 0.001$). Although there was a statistically significant direct relationship between predictors "part-time work" (AOR 2.664; 95% CI 1.415-5.017, $P \leq 0.02$) and "like SDL study" (AOR 18.589; 95% CI 9.622-5.911, $P \leq 0.001$) with a preference for DL compared TL in the future.

Adjusted odds ratio and binary categorical variables (gender, place of residence, years of study combining students' life satisfaction, faculty staff evaluation, SDL satisfaction, and AU) were analyzed with the inverse Wald step. The observed dependence is described by equation (2), equal to 50.5%.

$$P = 1 / (1 + e^{-z}) * 100\% = 1 / (1 + 0.98) * 100\% = 50.5\%$$

$$Z = -2.914 + 2.923 * X_{\text{like SDL}} + (0.980) * X_{\text{part-time work}}$$

$$Z = -2.914 + (2.923 * 1) X_{\text{Like SDL}} + (0.980) * X_{\text{part-time work}} = 0.98$$

The obtained regression model (P2) based on the Nigelerk coefficient determines a 43.5% SDL preference probability dispersion by medical students ($P < 0.001$). The threshold value of the predictive model (P) was 43.5%, showing a low probability of students choosing DL vs. TL. The sensitivity and specificity of the model at the threshold

Table 3. Assessment of participants' satisfaction with SDL by a regression model

variable	Satisfaction of SDL (A)			
	COR, 95% CI	p-value	AOR, 95% CI	p-value
Sex	1.787[1.246-2.562]	0.002	2.157 [1.282-3.629]	0.004
Country residence	0.171[0.115-0.253]	≤0.001	0.350 [0.207-0.592]	≤0.001
Years of study	1.746 [0.948-3.215]	0.071	1.495 [0.598-3.706]	0.392
Student's life satisfaction	0.581 [0.405-0.834]	0.003	0.338 [0.199-0.574]	0.016
Satisfaction of Academic Performance	7.488[4.896-11.452]	≤0.001	4.270 [2.479-7.356]	≤0.001
Part-time work	1.211 [0.846-1.735]	0.295	1.282 [0.767-2.143]	0.344
Like SDL study	0.05[0.03-0.08]	≤0.001	0.070 [0.040-0.122]	≤0.001

AOR - Adjusted Odds ratio, COR - Crude Odds ratio

Table 4. Regression analysis of participants' satisfaction with SDL (process, technical aspects, faculty activities) depending on predictors

Respondent characteristics (n=484)	Satisfaction with DL, OR, 95% OR		
	Process	Technical aspects	Faculty staff activity
Sex			
Female	0.877(0.611; 1.259)	1.282(0.878;1.871)	1.078(0.623;1.866)
Male			
Country of residence			
Non-resident	0.171(0.115;0.253) *	0.195(0.129;0.294) *	2.390(1.303;4.382) *
Resident			
Specialty of education program	-	-	-
Years of learning			
1-2 years	1.143(0.631;2.072)	2.809(1.284;6.143) *	0.418(0.200;0.874) *
3-4 years			
Learning language	-	-	-
Have part-day work			
No	1.078(0.749;1.550)	1.302(0.891;1.902)	0.679 (0.384;1.198)
Yes			
Assessment of Faculty Staff Activity			
Satisfactory	2.506(1.333;4.711) *	0.376(0.185;0.764) *	-
Unsatisfactory			
Satisfaction with academic performance			
satisfactory	7.488(4.896;11.452) *	2.103(1.399;3.163) *	0.148 (0.077;0.282) *
unsatisfactory			
Satisfaction with students' life			
Yes	0.581(0.405;0.834) *	1.867(1.273;2.739) *	0.872(0.502;1.517)
No			

Indicators are statistically significant, p<0.05

value were 82.4% and 78.2%, respectively.

The observed dependence is described by the equation (3):

$$P = 1 / (1 + e^{-z}) * 100\% = 1 / (1 + 8.346) = 10.7\%$$

$$Z = 2.889 + (-1.723) * X_{\text{likeSDL}}$$

$$Z = 2.889 + (-1.723 * 0) * X_{\text{likeSDL}} = 2.889$$

The obtained regression model (P3) based on the Nagelkerk coefficient determines only a 20.2% dispersion of the probability of preference for SDL compared with HL by medical students. The characteristics of the factors are shown in Table 4. The finding was that the predictor "like to study on SDL" was statistically significant with the inverse relationship (AOR 0.179: 95% CI 0.096-0.331, $P \leq 0.001$). The threshold value of the predictive model (P) was 20.2%, which shows the low probability of students choosing SDL over HL. The sensitivity and specificity of the model at the threshold value were 16.5% and 96.8%, respectively.

Discussion

In the current study, we evaluated the medical students' perception of Synchronous Distance Learning research. First, what percentages of students are satisfied with the SDL? Moreover, second, what are the prospects of distance learning according to students' opinions?

The study showed that 43.2% of respondents are satisfied with the SDL. The revealed differences in student satisfaction with SDL depended on an assessment of the educational process, technical aspects, teachers' work, and students' self-assessment of Academic Performance, which served as the basis for formulating an alternative hypothesis (Ha) about the ambiguous perception of SDL.

The regression analysis of SDL satisfaction on the process, technical aspects, and activities of the teaching staff revealed differences in the satisfaction of SDL students associated with the influence of predictors. When assessing the SDL (educational process) by students, it was found that the predictor satisfaction with the AP increases the chance of being satisfied with the DL by 7.5 times. However, the predictors of the country of residence (by 5.84 times), the activities of teachers (by 2.5 times), and student satisfaction life (1.72 times) reduce it. In the sample of respondents, non-residents of Kazakhstan from Asia, the Middle East, Central Asia, Europe, and Africa accounted for 54.8%. They made up one-third of the students who were satisfied with the STO and lived in their home country during the pandemic, which may have affected the final result of the study. For non-residents, the process of learning on the SDL (flexibility, accessibility, and functionality of the platforms on which educational materials are taught and

archived) by 5.13 times, and the assessment of the performance of teachers by 2.66 times reduced the chance of being satisfied with the SDL. The predictors "years of study," "satisfaction with AU," and "student life" increased the probability of student satisfaction from 2.81 to 1.87 times.

In SDL, the most common were technical problems. A direct relationship was determined between the satisfaction of the SDL (technical aspects) and the predictors "years of study," "satisfaction with the AP," and "satisfaction with student life". The predictor "years of study" increased the probability of satisfaction of junior students by 2.81 times, "satisfaction with AP" by 2.10 times, and "satisfaction with student life" by 1.87. Despite the students' satisfaction with the SDL, an inverse relationship of "country of residence" was revealed when non-residents of Kazakhstan were 5.13 times less likely to be satisfied with this type of education, and the predictor of the activity of faculty members decreased by 2.66 times the likelihood of being satisfied compared to residents.

The assessment of the SDL's satisfaction (the teaching staff's activity) revealed that the predictor "country of residence" increases the chance of being satisfied with the SDL by 2.39 times. Furthermore, the predictors "satisfaction with the AP" by four times and "years of study" by 2.4 times reduce the chance of being satisfied SDL.

The predictive regression model showed a higher probability of medical students' satisfaction with SDL by 59.5%. A direct relationship was established between SDL satisfaction and such predictors as gender) and AP satisfaction, and an inverse association of predictors such as country of residence, student life satisfaction, and likes to study at SDL. Only 45.5% of students in the future choose SDL vs. TL and 20.2% vs HL. Predictive models of students' choice of the type of education in the future revealed a preference for traditional education (42.6%) versus distance (18.8%) and hybrid (38.6%) education. The choice in the future DL by medical students compared to TL and HL was influenced by the same factors as the satisfaction of the SDL. The predominance of junior students among students who have chosen traditional education is determined by their lack of self-independence and immaturity of personality. An increase in the proportion of students with the choice of HL in the predictive model shows the future benefits of this type of education, associated with economic and personal benefits for students.

Our findings are consistent with other studies in the global educational environment. Authors from China presented a large-scale positive experience, where 200 million schoolchildren and 30 million university students have been studying online during the COVID-19 pandemic (6). The advantages of online learning have been identified, such as self-learning, archived materials, IT platforms, and interactive communications between students and teachers. In Kazakhstan, an analysis of SDL during the pandemic with 6 million students showed the existence of a critical assessment of it in society (8). Express-survey research of 31 300 parents and in-depth interviews with 65 parents, 15 children, nine administrators and teachers at schools, colleges, and universities, and 15 representatives of the Gov-

ernment of Kazakhstan has shown the existence of problems related to online learning, such as weak Internet infrastructure, inadequate interaction of all stakeholders, and biased statistical and analytical information (7).

The results have revealed both advantages and limitations of DL for medical students. Assessment of satisfaction and skills gained with SDL was not significantly different in terms of effectiveness but had higher ratings of satisfaction in comparison with TL (0.60; 95% CI 0.38-0.83; $P < 0.001$) according to results of systematic reviews and meta-analysis that included 7 RCTs involving 594 medical students from different countries (10). Also, it positively evaluated the impact of online medical education using video conferencing platforms during the COVID-19 pandemic in first-, second-, and third-year medical school students in India (15, 16, 18). Medical students' satisfaction and perceptions of online learning were determined in a prospective observational study using the Dundee Ready Education Environment Measure (DREEM). Students' perceptions were assessed using a questionnaire with a five-point Likert scale response. $\frac{1}{2}$ of the students were satisfied with online learning and evaluated their usefulness during self-isolation. Despite the positive reviews identified disadvantages of online learning such as insufficient knowledge of teachers by IT technology, lack of interactive learning, easy distractions, and technical problems. A systematic review of the effectiveness of SDL in teaching anatomy and surgery to medical school students was conducted according to the PRISMA evaluation system (1, 14) using 182 publications in CINAHL, Cochrane, EMBASE, and PubMed4 databases. Students' academic performance, motivation to learn, and time to complete assignments in SDL were compared to TL. Most student feedback was positive, with flexibility, efficiency, and increased motivation noted. However, some studies noted limitations of the SDL, including lack of personal contact with the instructor, a weak network of contacts, and decreased student concentration. Teacher feedback was positive, related to reasonable control of learning progress, quick updates of instructional material, and student involvement in the discussion. Problems were identified for SDL: lack of IT user experience among students, technical issues, and high costs for instructors. It is known for resident surgical specialty training using the e-model flipped classroom, hands-on online questions, teleconferencing, telemedicine, procedural simulation, and surgical videos (20). The authors recognized that SDL could not replace TL of surgery but could help bridge the gap in education for resident surgeons during the COVID-19 pandemic. A systematic review of e-learning for medical students in plastic surgery using the PubMed/MEDLINE, Scopus, and Embase databases (12) identified high satisfaction among surgeons and trainees with the knowledge gained, equivalent to traditional teaching methods. Publications on online learning during the pandemic in Nepal, India, and other countries of Southeast Asia (18-21) showed its low efficiency, connected with unpreparedness of educational programs and technical problems (absence of Internet and electronic means).

With the development of information technology in mod-

ern education, distance learning under appropriate conditions can be implemented in pre-diploma and post-diploma programs. The requirements for implementing online discipline courses are good information and educational platforms, availability and quality of Internet and electronic tools (PCs, laptops, mobile phones), well-designed teaching and learning programs, and availability of teachers and students with IT users' skills.

This study has limitations. First, the generalizability of our results may be low because we focused on the participants despite their heterogeneity. The cohort of students who participated in the study differed by historical residence and residence during the pandemic, characterized by different IT infrastructure, type and power of the Internet, and device availability. Most students in the current study used mobile phones for DL.

Conclusion

The research findings suggested that less than half of the respondent medical students were satisfied by distance learning during the COVID-19 pandemic when their satisfaction probability was significantly higher in the predictive model. The predictive model of the perspective of choice of distance learning did not show statistically significant results compared with traditional and hybrid education.

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Ethical Considerations

This study was approved by the Human Research Ethics Committee of the Faculty of Medicine and Healthcare of the Al-Farabi Kazakh National University (IRB-A397 on 31.03.2022).

Conflict of Interests

The authors declare that they have no competing interests.

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