




BMJ Open Factors affecting point-of-care ultrasound implementation in general practice: a survey in Danish primary care clinics

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ABSTRACT

Objective The implementation of point-of-care ultrasound (POCUS) in general practice varies, but it is unknown what determines this variation. The purpose of this study was to explore (1) the overall proportion of POCUS-users among general practitioners (GPs), (2) the current use of POCUS by GPs, (3) factors related to the implementation of POCUS in general practice and (4) GPs' concerns related to POCUS use in general practice.

Design An online survey was distributed in June 2019.

Setting General practice.

Participants GPs working in office-based primary care clinics in Denmark.

Main outcome measures The questionnaire was developed using mixed methods and included questions about participants' characteristics, past POCUS training and experience, capability, opportunity and motivation for using POCUS in the primary care setting. Results were summarised using descriptive statistics. Association between GPs' background characteristics and POCUS use was tested using logistics regression.

Results Responses were analysed from 1216 questionnaires corresponding to 36.4% of all GPs in Denmark. The majority (72.3%) of participants had previous POCUS experience, 14.7% had access to a POCUS device and 11.5% used POCUS. Several factors motivated participants to use POCUS. However, barriers existed such as lack of remuneration and high workload. Additionally, many GPs questioned their ability to scan with sufficient diagnostic accuracy and the impact of POCUS on the consultation. Of non-users, 28.7% believed they would be using POCUS in the future.

Conclusion Although, the majority of GPs had past experience with POCUS and felt motivated to use it, few had implemented POCUS. Several factors influenced the GPs' capability, opportunity and motivation for using POCUS and several concerns were registered by non-users.

INTRODUCTION

Point-of-care ultrasound (POCUS) is now used by physicians across clinical specialties.^{1,2} The development is caused by technological advances making smaller, better and cheaper ultrasound equipment accessible outside the

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is the first European study to explore the dissemination of point-of-care ultrasound in a general practice setting without regulation or financial incentives to drive the implementation.
- ⇒ The survey was built from explorative in-depths interviews with 25 general practitioners (GPs) and items were further developed and tested in focus groups including a total of 11 GPs.
- ⇒ The response rate to the survey was low. Although analysis suggested a representative sample, selection bias cannot be omitted.

radiology department.^{2,3} Moreover, defining POCUS, as a rapid and focused add-on to the traditional physical examination of patients, makes the examination feasible for frontline clinicians.³

It has been suggested that POCUS may also be a future tool for general practitioners (GPs) working in primary care owing to: the onward march of POCUS use into medical schools,⁴ the limitations of the traditional physical examination of patients,⁵ the increased complex medical conditions in patients seen in general practice⁶ and society's demand for high-quality healthcare.¹

However, using POCUS is a complex task and several aspects of implementing POCUS in general practice have not yet been explored including the barriers and facilitators that influence the uptake of the technology. Furthermore, the available evidence-base concerning POCUS use in an office-based general practice setting is still sparse.⁷ Previous studies describing the use of POCUS have been limited to exploring the use in somewhat selected groups of early adapters of the technology⁸ and results from these studies may not be generalisable.

The uptake of POCUS in general practice varies among geographical areas and between



GPs in each area.^{9,10} Why some GPs adopt the technology while others are reluctant is not well described. However, it has been suggested that factors like financial incentives,^{10,11} access to ultrasound examinations in secondary care^{10,12} and previous experience with POCUS use from other settings¹⁰ may be of influence. Still, non-users may have concerns that have not yet been identified.

Implementation theories have been developed to achieve enhanced understanding of aspects of implementation on an individual and/or collective level.¹³ According to the *COM-B* model introduced by Michie *et al*, *Capability*, *Opportunity* and *Motivation* are considered key factors for changing clinical *Behaviour* of individual healthcare professionals.¹⁴ Still, no previous research has explored either the factors driving the behaviour of the early adopters,⁸ who have implemented POCUS in their daily clinical work without guidelines, financial and organisational support, or the factors preventing non-users from adopting the technology. Hence, we do not know which factors are of influence or if barriers and concerns may prevent a broader implementation in the general practice community.

Therefore, the aims of this study were to explore (1) the proportion of POCUS-users among GPs in Denmark, (2) the current use of POCUS by the GPs, (3) factors related to the implementation of POCUS in general practice and (4) GPs' concerns related to POCUS use.

MATERIAL AND METHODS

Study design

Cross-sectional survey.

Setting and participants

Data were collected from general practice in Denmark, where office-based GPs provide primary healthcare for patients listed with their clinics and act as gatekeepers to secondary healthcare through a referral system. Consultations and treatments are tax-financed and free-of-charge for patients. GPs are paid through a combination of capitation and fee-for-service negotiated as a collective agreement between the organisation of GPs in Denmark (PLO) and the Danish regions.¹⁵ However, in Denmark there is no financial support in relation to the introduction of POCUS or fee for performing POCUS examinations in general practice and GPs must cover the costs related to buying the ultrasound device, participating in ultrasound courses, using extra time in the consultation performing POCUS, in addition to the lost income due to absence from the clinic during training.¹⁶

All GPs in Denmark registered by PLO (corresponding to 99.9% of GPs working in Denmark) were eligible to participate in the study. On 7 June 2019, an email was distributed by PLO including a short description of the study purpose and a link to the study questionnaire. A reminder email followed on 27 June 2019.

Developing the questionnaire

The questionnaire for this study was developed and validated through five steps (figure 1) using a mixed-method

sequential design.¹⁷ First, the research group developed a conceptual model based on a previous literature review⁷ and informal focus groups with GPs. The conceptual model included domains of interest in relation to the implementation of ultrasound in general practice and was used to build an interview guide. Second, 25 Danish GPs—both POCUS users and non-users—were interviewed exploring experiences with POCUS use in general practice.¹⁸ The interviewees were recruited stepwise through general practice networks aiming for maximum variation in the sample in terms of characteristics of the GPs. Semi-structured interviews were conducted using an explorative phenomenological approach. The interviews were audio-recorded, transcribed verbatim and analysed using an inductive cross-case analysis.¹⁹ Third, the analytical themes from the interviews were converted into items in a preliminary version of the questionnaire. All statements made by the interviewees related to implementation aspects were included in the drafted version of the questionnaire. We also included aspects identified in patient interviews.²⁰ Fourth, the drafted questionnaire was tested and further developed in two focus groups interviews including a total of 11 GPs. Participants systematically discussed each item in the questionnaire and made suggestions for changes. Items were re-phrased, missing response categories were identified, and related statements made by the interviewees were combined. Adaptions followed each focus group. Fifth, a new version of the questionnaire was pilot-tested using 'think-aloud' technique in individual interviews with five GPs. This was a final test of face-validity, comprehension, and feasibility. Only minimal adaptions followed this step.

Outcome measures

The final questionnaire consisted of 14 single-choice items and five multiple-choice items with different categorical response categories, six battery single-choice items with ordinal answer categories (48 items in total) and five free-text items where participants could type in numbers (continuous data) (online supplemental file 1).

Characteristics of the GPs and clinics

The questionnaire encompassed items about GP's gender (male, female), age, seniority (years as a GP) and terms of employment (owner of practice, employed, other) as well as organisation (solo-practice, partnership practice, other), location (city, rural, mixed), region (North Denmark Region, Central Denmark Region, Region of Southern Denmark, Region Zealand or Capital Region of Denmark), distance to the nearest radiology department (km), number of GPs working in the clinic and number of patients listed with the clinic.

Dissemination

Participants were asked if they used POCUS in their daily work in the clinic, during out-of-hours service, and if they believed all GPs would be performing POCUS in the future. In addition, non-users were asked if they thought

Figure 1. Developing the questionnaire.



GPs = General Practitioners, POCUS = Point-of-care ultrasound

* The research group consisted of one radiologist with extensive experienced in POCUS use, one GP and professor in general practice with POCUS experience, one GP and professor in general practice with expertise in the development of questionnaires, one GP and associate professor in general practice with expertise in qualitative methods and one phd student exploring the use of POCUS in general practice.

Figure 1 Developing the questionnaire.

POCUS was a relevant examination in general practice, and if they believed they would themselves be performing POCUS in the future.

Usage

The use of POCUS was explored through the frequency of use during daily work in the clinic, during out-of-hours service, and the type of diagnostic and/or procedure-related POCUS examinations performed.

Implementation

In line with the COM-B model¹⁴ we included all GP statements from the interviews concerning factors related to performing POCUS (capability), using POCUS (opportunity) and motivational factors (motivation). In addition, we included GPs’ statements describing general concerns related to the use of POCUS in general practice. The GPs were given five response options about their agreement



to these statements: 'yes, to a high extent', 'yes, to some extent', 'yes, to a little extent', 'no' or 'unsure'. We further explored the GPs' capability by asking them to declare any prior POCUS training and/or experience and the GPs' opportunity by asking them to declare if they had access to an ultrasound device in their clinic and which type of ultrasound device. The statements related to implementation are shown in the Results section and the development of these items is elaborated in [figure 1](#).

Data management and analysis

Data were collected anonymously using SurveyXact (Rambøll, Aarhus, Denmark), exported to a secure server at Aalborg University, and then analysed using STATA V.15.0 (StataCorp, College Station, Texas, USA).

Categorical variables were summarised in proportions and continuous variables using mean and 95% CI (median and IQR if not normally distributed). As POCUS use was considered to influence outcomes related to implementation aspects and concerns related to POCUS use we preplanned to present these outcomes for the users and non-users separately. The overall percentage of POCUS-users versus non-users who agreed with each statement (including 'yes to a high extent', 'yes to some extent' and 'yes to a little extent') will be presented in the main text, while the percentage in each response category is presented in the corresponding figure.

Associations between GP or clinic characteristics and POCUS use were tested using a logistic regression model and presented as adjusted ORs as elaborated in [table 1](#). Missing values, owing to premature termination of the questionnaire and the number of participants were declared for each outcome.

Patient and public involvement statement

Concurrently with developing the questionnaire for this study, we were developing a patient questionnaire for a different study.²⁰ During the validation of the patient questionnaire, a total of 23 patients were interviewed about their reflections on POCUS use in general practice. The purposes of these interviews were (1) to validate the patient questionnaire for content relevance and (2) to identify missing items or domains for the GP questionnaire for this study. The patients were recruited from four different general practice clinics aiming for variation in geographical location, age, gender and POCUS experiences. Domains and aspects identified by the patients were incorporated into the preliminary version of the questionnaire for this study.

RESULTS

Of 3365 invited GPs, 1226 (36.4%) responded to the survey. Ten were excluded because they did not work as GPs in Denmark leaving 1216 participants. GP and clinic characteristics are provided in [table 1](#). Comparison between our sample and the background population of

GPs in Denmark is provided in online supplemental file 2.

Dissemination

Overall, 11.5% (95% CI 9.7 to 13.3) used POCUS in their daily work and 0.8% (0.3 to 1.3) during out-of-hours service. POCUS use was significantly associated with being male and being below 50 years of age ([table 1](#)).

A total of 29.2% (26.6 to 31.8) of participants believed POCUS would be used by all GPs in the future, while 23.9% (21.5 to 26.2) did not, and 40.0% (37.2 to 42.7) were unsure. Of 1076 non-users 50.0% (47.0 to 53.0) believed POCUS was a relevant examination in general practice (28.6% (25.8 to 31.3) did not and 14.6% (12.5 to 16.7) were unsure) and 28.7% (26.0 to 31.4) believed they would be using POCUS in the future (36.5% (33.6 to 39.4) did not and 27.4% (24.7 to 30.0) were unsure).

Usage

There was a large variation in the frequency of POCUS use among the 140 POCUS users with 53.6% (45.3 to 61.9) using it daily, 32.9% (25.1 to 40.7) weekly, 12.1% (6.7 to 17.5) monthly and 0.7% (−0.6 to 2.0) less than monthly (0.7% were unsure of their use). Ten GPs used POCUS during out-of-hours service of whom three used it each time they were on duty. Variation was also found regarding the indication for using POCUS ([figure 2](#)): 77.9% (71.0 to 84.8) of POCUS users declared that they often or sometimes scanned to confirm/disconfirm a specific clinical condition, 67.1% (59.3 to 74.9) to practice and train their own scanning skills, 55.0% (46.7 to 63.2) to remedy the patient's concern without having a medical reason for performing the scan, 50.7% (42.4 to 59.0) to make sure obvious pathology was not overlooked, 29.2% (21.7 to 36.7) to search for reasons for the patients symptoms, 28.6% (21.1 to 36.1) as a standardised part of their examination, and 20.0% (13.4 to 26.6) to screen asymptomatic patients.

The POCUS-users registered that they used a range of different diagnostic scanning modalities and procedural scans ([figure 3](#)). The most common applications registered were gynaecological or obstetric: 92.8% (88.5 to 97.1), abdominal: 67.1% (59.3 to 74.9) and musculoskeletal: 61.4% (53.3 to 69.5) examinations. The majority of POCUS users scanned several anatomical areas, whereas some restricted themselves to just one: 17.8% (11.5 to 24.1), two: 15.0% (9.1 to 20.9) or three: 8.6% (4.0 to 13.2) anatomical areas.

Implementation

Factors relating to capability, opportunity and motivation are described in [figure 4](#).

In terms of capability, 72.3% (69.8 to 74.8) of the 1216 participating GPs had previous POCUS experience (online supplemental file 3). POCUS users had begun using POCUS in general practice within: <1 year: 28.6% (21.1 to 36.1), 1–2 years: 20.7% (14.0 to 27.4), 3–4 years: 27.1% (19.7 to 34.4), 5–10 years: 15.0% (9.1 to 20.9) or

Table 1 Participant characteristic

	POCUS users (N=140) N (%)	Non-users (N=1076) N (%)	Whole sample (N=1216) N (%)	Association to POCUS use (N=1122) Adjusted OR (95% CI)‡
Gender				
Male	86 (61.4)	454 (42.2)	540 (44.4)	2.2 (1.5 to 3.3)
Missing	6 (4.2)	80 (7.4)	86 (7.1)	
Age				
<50 years	74 (52.8)	437 (40.6)	511 (42.0)	1.9 (1.3 to 2.8)
Mean (SD) years	50.6 (8.9)	52.2 (8.7)	52.0 (8.7)	
Missing	6 (4.2)	82 (7.6)	88 (7.2)	
Experience as a GP				
<5 years	23 (16.4)	155 (14.4)	178 (14.6)	
5–10 years	41 (29.3)	252 (23.4)	293 (24.1)	
20 years	41 (29.3)	343 (31.9)	384 (31.6)	
>20 years	29 (20.7)	244 (22.7)	273 (22.5)	
Missing	6 (4.2)	82 (7.6)	88 (7.2)	
Terms of employment				
Owner of practice†	131 (93.6)	956 (88.8)	1087 (89.4)	
Missing	6 (4.2)	82 (7.6)	88 (7.2)	
Type of practice				
Partnership practice	95 (67.9)	755 (70.2)	850 (69.9)	0.7 (0.4 to 1.1)
Solo-practice	39 (27.9)	224 (20.8)	263 (21.6)	
Other**	0 (0.0)	15 (1.3)	15 (1.4)	
Missing	6 (4.2)	82 (7.6)	88 (7.2)	
Number of GPs working in the practice				
>3 GPs	47 (33.6)	337 (31.3)	384 (31.6)	1.1 (0.7 to 1.6)
2–3 GPs	58 (41.4)	483 (44.9)	541 (44.5)	
1 GP	29 (20.7)	169 (15.7)	198 (16.3)	
Missing	6 (4.2)	87 (8.1)	93 (7.6)	
Number of patients listed with the practice				
<2000 patients	28 (20.0)	164 (15.2)	192 (15.8)	
2000–5000 patients	62 (44.3)	469 (43.6)	531 (43.7)	
>5000 patients	44 (31.4)	356 (33.1)	400 (32.9)	
Missing	6 (4.2)	87 (8.1)	93 (7.6)	
Location of practice				
Rural	26 (18.6)	144 (13.4)	170 (14.0)	1.4 (0.9 to 2.3)
Urban	66 (47.1)	525 (48.8)	591 (48.6)	
Mixed	42 (30.0)	324 (30.1)	366 (30.1)	
Missing	6 (4.2)	83 (7.7)	89 (7.3)	
Region				
North Denmark Region	13 (9.1)	93 (8.6)	106 (8.7)	
Central Denmark Region	26 (18.6)	243 (22.6)	269 (22.1)	
Region of Southern Denmark	52 (37.1)	211 (19.6)	263 (21.6)	
Region Zealand	12 (8.6)	134 (12.5)	146 (12.0)	
Capital Region of Denmark	31 (22.1)	312 (29.0)	343 (28.2)	
Missing	6 (4.2)	83 (7.7)	89 (7.3)	

Continued

Table 1 Continued

	POCUS users (N=140) N (%)	Non-users (N=1076) N (%)	Whole sample (N=1216) N (%)	Association to POCUS use (N=1122) Adjusted OR (95% CI)‡
Distance to radiology department				
>20 km	27 (19.2)	150 (13.9)	177 (14.6)	
11–20 km	24 (17.1)	201 (18.7)	225 (18.5)	
5–10 km	30 (21.4)	195 (18.1)	225 (18.5)	
<5 km	53 (37.9)	445 (41.4)	498 (41.0)	
Missing	6 (4.2)	85 (7.9)	91 (7.5)	

*General practitioners (GPs) who are employed in out-of-hours services or as consultants.

†GPs who are not owners includes participants who are employed or working as substitutes.

‡Adjusted ORs calculated using a logistic regression model. For this model the following characteristics were dichotomised: gender (male/female), GP age (<50 years/>50 years), type of practice (partnership practice/not partnership practice), practice size (>3 GPs in the practice/<3 GPs in the practice) and practice location (rural/ not rural). Based on the findings from previous studies (reference 9 16 26 38), we hypothesised that using POCUS would be associated to the GP being male and below 50 years of age whereas the clinic would be a larger partnership practice located in a rural area. Hence, we adjusted for these factors in the model.

>10 years: 7.1% (2.8 to 11.4). Among non-users, 4.1% (2.9 to 5.3) had previously used POCUS in a general practice setting. Still, concerns were registered regarding the GPs ability to obtain POCUS competence following training: POCUS users: 62.1% (54.1 to 70.1) and non-users 80.2% (77.8 to 82.6), GPs ability to maintain POCUS competence with low frequency of POCUS use in general practice: 66.4% (58.6 to 74.2) and 84.0% (81.8 to 86.2), the quality of affordable POCUS equipment: 42.9% (34.7 to 51.1) and 68.2% (65.4 to 71.0), the risk of diagnostic insecurity: 65.7% (57.8 to 73.6) and 80.9% (78.6 to 83.2), the risk of overlooking serious disease: 50% (41.7 to 58.3) and 76.8% (74.3 to 79.3), the risk of not knowing when to stop: 62.1% (54.1 to 70.1) and 68.7% (66.0 to 71.2), the risk of misdiagnosis: 70.7% (63.1 to 78.2) and 81.3% (79.0 to 83.6), the liability in case of misdiagnosis: 59.2% (51.1

to 67.3) and 72.2% (69.5 to 74.9), the risk of unnecessary over-examination: 42.1% (33.9 to 50.3) and 71.7% (69.0 to 74.4) and the number of incidental findings: 64.2% (56.3 to 72.1) and 80.8% (78.4 to 83.1), respectively.

In terms of opportunity, 14.7% (12.7 to 16.7) of participants had access to an ultrasound device in their clinic (online supplemental file 4). The most commonly registered barriers for use were general workload in general practice: 83.6% (77.5 to 89.7) for POCUS users 77.4% (74.9 to 79.9) for non-users, respectively), time spent performing POCUS: 83.6% (77.5 to 89.7) and 77.4% (74.9 to 79.9), lack of fee for performing POCUS: 80.0% (73.3 to 86.6) and 86.9% (84.9 to 88.9), the price of the POCUS equipment: 75.0% (67.8 to 82.2) and 88.1% (86.2 to 90.0), the amount of extra training needed: 69.3% (61.6 to 76.9) and 79.4% (77.0 to 81.8), lack of curriculum for

Indication for performing point-of-care ultrasound

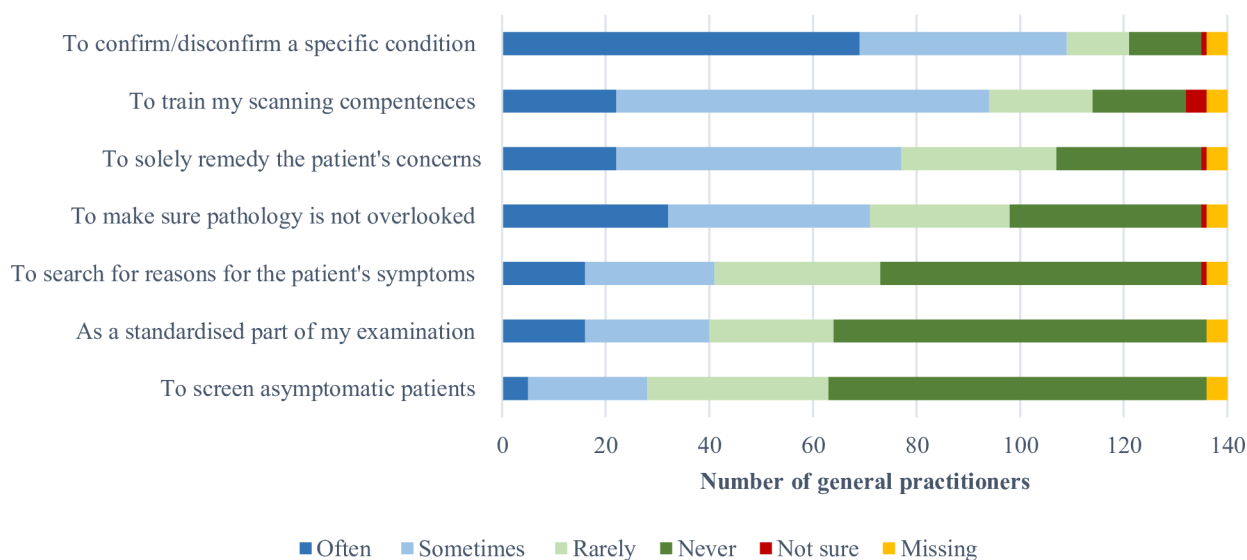


Figure 2 Indication for performing point-of-care ultrasound.

Figure 3. Point-of-care examinations performed by general practitioners

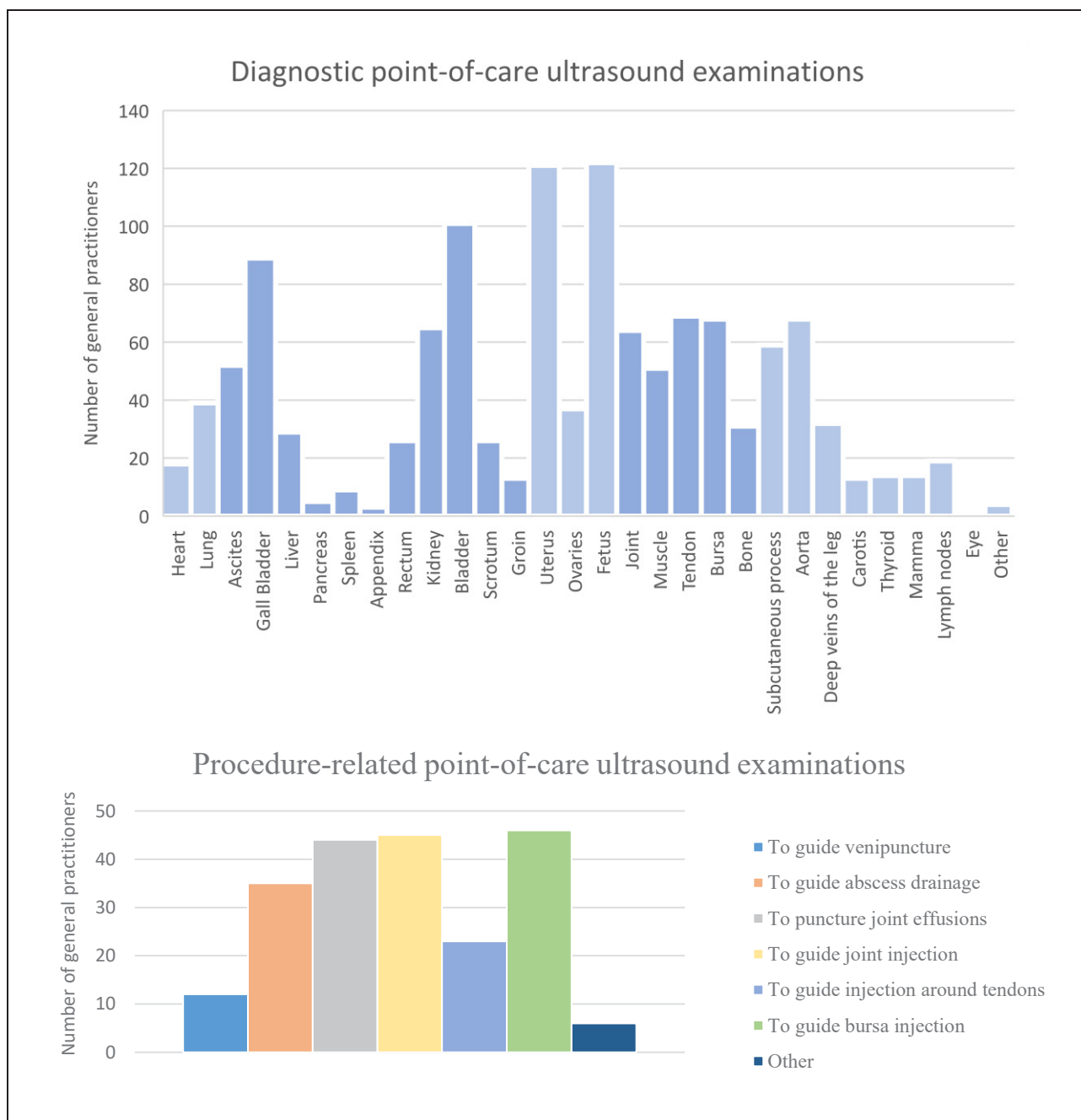


Figure 3 Point-of-care examinations performed by general practitioners.

general practice POCUS: 45.7% (37.4 to 54.0) and 74.3% (71.7 to 76.9) and lack of guidelines: 62.1% (54.1 to 70.1) and 76.2% (73.7 to 78.7). Opposition from colleagues: 15.0% (9.1 to 20.9) and 15.1% (13.0 to 17.2) and supply of ultrasound courses: 46.4% (38.1 to 54.7) and 21.3% (18.8 to 23.7) seemed to be less important factors, while fewer POCUS users than non-users registered that they

had easy access to the examination in secondary care: 37.8% (29.8 to 45.8) and 61.7% (58.8 to 64.6).

In terms of motivation for using POCUS in general practice, a larger proportion of POCUS users than non-users agreed that POCUS use in general practice could improve the diagnostic process : POCUS users: 94.3% (90.5 to 98.1) and non-users: 74.9% (72.3 to 77.5),



Non-users' agreement (N=1076)						POCUS users' agreement (N=140)						
Yes (high extent)	Yes (some extent)	Yes (lesser extent)	No	Unsure	Missing		Yes (high extent)	Yes (some extent)	Yes (lesser extent)	No	Unsure	Missing
Statements related to the GPs' capability for performing POCUS (I have concerns regarding...)												
385	344	134	131	22	60	GPs ability to obtain POCUS competence	18	34	35	47	0	6
436	343	125	88	24	60	GPs ability to maintain POCUS competence	15	35	43	40	1	6
249	307	178	180	102	60	The quality of affordable POCUS equipment	8	28	24	71	3	6
309	346	216	110	35	60	The risk of diagnostic insecurity	7	24	61	40	2	6
279	315	233	151	38	60	The risk of overlooking serious disease	9	20	41	61	3	6
190	304	246	233	41	62	The risk of not knowing when to stop	12	22	53	45	2	6
234	327	314	102	37	62	The risk of misdiagnosis	4	28	67	33	2	6
314	258	205	163	74	62	The liability is case of misdiagnosis	11	27	45	42	9	6
250	318	204	192	50	62	The risk of unnecessary over-examination	2	25	32	71	4	6
285	348	237	101	43	62	The number of incidental findings	4	28	58	42	2	6
Statements related to the GPs' opportunity for performing POCUS (My use of POCUS in general practice is limited by...)												
437	279	117	141	59	43	General workload	34	62	21	17	0	6
428	302	103	116	84	43	Time spent on POCUS	28	60	29	17	0	6
705	150	80	57	41	43	Lack of fee for performing POCUS	50	41	21	19	3	6
688	179	81	48	37	43	Prize of the POCUS equipment	48	36	21	28	1	6
398	274	182	140	39	43	The amount of extra training needed	14	43	40	33	4	6
366	258	175	147	86	44	Lack of a general practice suited curriculum	13	25	39	53	4	6
392	261	167	133	80	43	Lack of recommendations for implementation	16	38	33	44	3	6
191	251	222	328	41	43	Already easy access to ultrasound examinations	3	17	33	77	4	6
21	47	94	657	213	44	Opposition form colleagues	0	4	17	104	9	6
23	77	130	390	412	44	The supply of POCUS courses available	8	22	35	63	6	6
Statements related to the GPs' motivation for performing POCUS (I believe use of POCUS in general practice can...)												
195	386	225	99	143	28	Improve the diagnostic process	76	49	7	2	0	6
145	341	235	169	158	28	Qualify my referrals	63	52	13	4	2	6
207	367	222	109	143	28	Entail earlier diagnosis for patients	73	49	10	2	0	6
156	276	257	187	172	28	Enable me to clarify more patients (less referrals)	59	55	15	3	2	6
121	250	253	252	172	28	Increase my performance as a GP	57	56	17	2	2	6
168	247	154	270	209	28	Increase my job satisfaction	95	32	3	1	3	6
207	299	171	208	163	28	Give me professional contentment	96	32	4	0	2	6
194	298	211	188	157	28	Give variation in my everyday work	84	39	5	4	2	6
175	260	244	229	135	33	Reduce the waiting time for patients	43	38	31	14	8	6
97	217	206	259	264	33	Increase the patients' trust in the GP	35	61	23	5	10	6
155	284	198	164	242	33	Create an interest for the specialty and recruit more GPs	68	44	11	7	4	6
Statements describing general concerns (I am concerned that POCUS use in general practice can...)												
342	256	159	232	35	52	Entail a shift of tasks between primary and secondary care	7	17	28	80	2	6
313	343	143	191	34	52	Have a negative effect on other tasks	7	28	20	79	0	6
129	175	171	468	81	52	Create competition between clinics	0	9	28	89	8	6
276	312	181	224	31	52	Make the GP move away from core competences	3	11	33	87	0	6
107	158	189	503	67	52	Fundamentally change the way GPs work	2	14	15	103	0	6
132	282	219	339	30	74	Technification of the consultation	2	16	25	91	0	6
45	120	153	632	52	74	Increase the distance between doctor and patient	0	5	4	125	0	6
142	305	206	313	36	74	Remove focus from the dialogue with the patient	1	13	29	91	0	6
157	287	272	237	49	74	Give patients a false reassurance	1	19	45	65	4	6
243	349	214	160	36	74	Create patient expectations for more advanced diagnostics	7	29	43	53	2	6
67	207	252	383	93	74	Increase patients' concerns	0	9	24	96	5	6

POCUS= point-of-care ultrasound, GP=general practitioner, POCUS-users: GPs who use POCUS in their daily practice, Non-users= GPs, who do not use POCUS.

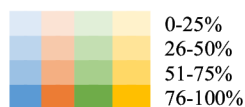


Figure 4 Agreement with statements.

qualify referrals to secondary care: 91.4% (86.8 to 96.0) and 67.0% (64.2 to 69.8), provide earlier diagnosis: 94.3% (90.5 to 98.1) and 74.0% (71.3 to 76.6), enable

them to clarify more patients on their own (and reduce the number of referrals): 92.1% (87.6 to 96.6) and 64.0% (61.1 to 66.9), increase GP performance: 92.9% (88.6

to 97.2) and 57.9% (54.9 to 60.9), increase job satisfaction among GPs: 92.9% (88.6 to 97.1) and 52.9% (49.9 to 55.9), increase professional contentment among GPs: 94.3% (90.5 to 98.1) and 63.0% (60.1 to 65.9), provide variation in everyday work for GPs: 91.4% (86.8 to 96.0) and 65.3% (62.5 to 68.1), reduce the patients' waiting time for an ultrasound examination: 80.0% (73.3 to 86.6) and 63.1% (60.2 to 66.0), increase the patients' confidence in the GP: 85.0% (79.1 to 90.9) and 48.3% (45.3 to 51.3) and create interest for the specialty among younger GPs and thereby recruit more GPs: 87.9% (82.5 to 93.3) and 59.2% (56.3 to 62.1), respectively.

Concerns related to POCUS use in general practice

Non-users, more often than POCUS users, registered concerns that POCUS would affect the division of tasks between primary and secondary healthcare: POCUS users: 37.1% (29.1 to 45.1) and non-users: 70.3% (67.6 to 73.0), have a negative effect on other tasks: 39.3% (31.2 to 47.3) and 74.3% (71.7 to 76.9), give rise to competition between clinics: 26.4% (19.1 to 33.7) and 44.1% (41.1 to 47.1), make GPs move away from core competences: 33.6% (25.8 to 41.4) and 71.5% (68.8 to 74.2), fundamentally change the way GPs work: 22.1% (15.2 to 29.0) and 42.2% (39.2 to 45.2), technify the consultation: 30.7% (23.1 to 38.3) and 58.8% (55.9 to 61.7), increase the distance between the doctor and the patient: 6.4% (2.3 to 10.5) and 29.6% (26.9 to 32.3), remove focus from the dialogue: 30.7% (23.1 to 38.3) and 60.7% (57.8 to 63.6), lead to false reassurance: 46.4% (38.1 to 54.7) and 66.5% (63.7 to 69.3), increase the patients' expectations for more advanced care: 56.4% (48.2 to 64.6) and 74.9% (72.3 to 77.5), or increase the patients' concern: 23.6% (16.5 to 30.6) and 48.9% (45.9 to 51.9).

DISCUSSION

Statement of principal findings

In this sample, we found that 11.5% of GPs in Denmark used POCUS in their clinical work and POCUS was used for a variety of indications to examine several anatomical areas. In terms of implementation, POCUS-users were highly motivated, but the majority felt highly limited by financial aspects. Many non-users were also motivated, but apart from financial aspects they also registered factors related to their capability and the lack of guidance as highly limiting for their use of POCUS. In addition, many non-users were concerned that POCUS would take away time from other tasks, distracting the core GP role and directing it away from a patient-centred focus.

Strengths and weaknesses of the study

It is well-known that response rates are low in surveys targeting physicians.^{21 22} We had a 36% response rate, which may be an indicator of a risk of selection bias as GPs responding to our survey may have had a special interest in POCUS. We were not able to adjust for selection bias by using for example an inverse probability

weighting, as this technique required individual data on non-participants, which was unavailable for us. However, the comparison between our sample and the complete list of GPs in Denmark (online supplemental file 2) did not reveal differences in GPs characteristics with exception of number of GPs per practice, where the proportion of participants from practices with more than three GPs was slightly larger in our sample. Still, we do not rule out the risk of selection bias and acknowledge that our user frequency of 11.5% could be overestimated. To prevent overemphasising POCUS users, we separated responses from POCUS-users and non-users in relation to the implementation issues. Recognising the possibility of non-response bias, the responses from non-users might better reflect the overall population of GPs in Denmark.

As a result of our decision to include all factors mentioned by the interviewees in the final questionnaire to achieve high content validity, the final questionnaire became long, making it time-consuming to complete the survey. As a result, 7.7% (highest among non-users) dropped out ahead of completion, which most likely were those GPs with least interest in POCUS in general practice.

The study was conducted in Denmark and the financial barriers may not be relevant in countries where GPs are employed by foundations or have their expenses relating to POCUS covered by remuneration or patients' payment. In addition, the lack of official guidelines and requirements for POCUS use in general practice in Denmark makes these POCUS-users a selected group of early-adapters and first-movers.^{8 16} In other countries, the use of POCUS may have a different organisational anchoring and support.¹⁰

Findings in relation to other studies

Compared with a previous survey⁹ the use of POCUS in general practice in Denmark might be increasing, despite the lack of financial support. Two previous studies from Norway and Switzerland have also reported increasing use of POCUS in general practice by summarising remuneration codes for specific types of POCUS.^{23 24} Previous cohort studies conducted among first-movers of POCUS technology^{25 26} have shown that POCUS is used for a variety of different applications which our study confirms. This variation may be explained by POCUS-users composing their own individual portfolios based on self-interest, patients seen in their practice, and their experience of relevance of the different types of scans.¹⁶ In addition, we found that POCUS was used for a range of indications, some of which are far from the POCUS definition.³

Similar to the adoption of other technologies and procedures in general practice^{27 28} many factors may influence implementation. Most participants were motivated by several factors and 72.3% of the participants in our study had previous POCUS experience—primarily from residency training. Still, not all GPs with past experience were using POCUS, which is in line with the findings from other surveys.^{11 12 29} In a previous study,¹¹



financial aspects and workload in general practice were registered as highly limiting factors by almost all participants. Another study pointed to insufficient training as an obstacle for use.³⁰ Our study offered insight into additional reservations and concerns. More than half of the participants had concerns in relation to GPs' ability to obtain and maintain POCUS competence, the diagnostic accuracy of a POCUS performed in general practice, as well as the quality of the affordable equipment. Today, there is not enough evidence to support or dispute such specific concerns, but for some non-users the concerns may be caused by a miscomprehension and direct comparison between traditional ultrasound examination performed by imaging experts and POCUS performed by frontline clinicians. The understanding that POCUS use is something different than the traditional ultrasound examination³¹⁶ may not be widespread. Still, POCUS is an operator-dependent examination and if GPs are insufficiently trained, there is a risk of misinterpretation of ultrasound images, which could lead to inappropriate care, for example, misdiagnosis, non-diagnosis, overdiagnosis and thereby undertreatment and overtreatment.³¹ General minimum requirements for ultrasound training³² and equipment³³ have been outlined, but research has shown a large variation in the ultrasound training of GPs.³⁴ We do not know if a lack of regulation, minimum requirements or financial support to GPs who aim to start using POCUS in their practice makes some GPs compromise on quality and choose a cheap ultrasound device to lower the cost or a short training course to reduce the absence from the clinic. Many non-users in this study were missing guidance in terms of a curriculum and recommendations, and as highlighted previously,^{18 34} educational programmes and guidelines specifically designed for GPs would probably result in an increased uptake of the technology.

Many non-users had concerns related to the impact of POCUS on the consultation and the doctor–patient relationship. This concern may be a general reaction to the introduction of new technologies.⁶ However, negative effects were not revealed in a previous qualitative study exploring GPs' experiences with using POCUS in the consultation¹⁶ or in a survey exploring patient experiences with POCUS use in general practice.²⁰ Still, the GPs in the qualitative study¹⁶ expressed concern that patients may put too much trust in the technology.

Implications for research and practice

This study shows that many GPs see a potential for POCUS use in general practice, but the reluctance that some GPs have may be caused by other barriers and concerns than merely financial aspects. Even though studies suggest a high impact of POCUS in the diagnostic process^{25 35} and potential cost savings,^{36–38} evidence supporting POCUS use in general practice is still sparse. More research is needed to explore the non-users' concerns in relation to GPs' ability to obtain and maintain POCUS competence as well as the impact of POCUS on overall patient care including diagnostic test accuracy and patients'

prognosis. Still, the use is increasing, and efforts must be made to offer the educational and organisational support that the participants in our study called for.

CONCLUSION

This study showed that most GPs had past experience with POCUS and felt motivated to use it, but few had implemented the technology in clinical practice. In terms of implementation, several factors influenced the GPs' capability, opportunity and motivation for using POCUS and several concerns were registered by non-users.

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Contributors The named authors have made substantial contributions to the study, as well as drafting the article and revising it critically for important intellectual content. The study was designed by JB, OG, ASD, MBBJ and CAA in collaboration. The preceding interviews were conducted and analysed by ASD and CAA. The questionnaire was developed by JB, MBBJ and CAA, CAA had the responsibility of data collection and analysis of the data. MBBJ and CAA wrote the first draft of the article. CAA acts as the guarantor.

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Competing interests None declared.

Patient and public involvement Concurrently with developing the questionnaire for this study, we were developing a patient questionnaire for a different study^[20]. During the validation of the patient questionnaire, a total of 23 patients were interviewed about their reflections on POCUS use in general practice. The purpose of these interviews were (1) to validate the patient questionnaire for content relevance and (2) to identify missing items or domains for the GP questionnaire for this study. The patients were recruited from 4 different general practice clinics aiming for variation in geographical location, age, gender, and POCUS experiences. Domains and aspects identified by the patients were incorporated into the preliminary version of the questionnaire for this study.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants. The study was performed in accordance with the Declaration of Helsinki. The project protocol was presented to Regional Scientific Committee (The North Denmark Region Committee on Health Research Ethics), who responded that according to Danish law (komitétovens § 14, stk. 2), no ethical approval was needed for this project. The project was registered and conducted according to the regulations of the Danish Data Protection Agency. The study was also approved by the Committee of Multipractice Studies in General Practice (MPU-20-2016). Prior to the study, the participating GPs were informed about the purpose. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The anonymised transcriptions from the interviews, the collected survey-responses and the analytic datasets are available stored at Center for General practice at Aalborg University, Denmark according to regulations by the Danish Data Protection Agency. Anonymised data are available on request by contacting the corresponding author.

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