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Digital tools/eHealth to support CKD self-management: A qualitative study of perceptions, attitudes and needs of patients and health care professionals in China

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ABSTRACT

Background: A growing body of evidence supports the potential effectiveness of electronic health (eHealth) self-management interventions in improving disease self-management skills and health outcomes of patients suffering from chronic kidney disease (CKD). However, current research on CKD eHealth self-management interventions has almost exclusively focused on high-income, western countries.

Objective: To inform the adaptation of a tailored eHealth self-management intervention for patients with CKD in China based on the Dutch Medical Dashboard (MD) intervention, we examined the perceptions, attitudes and needs of Chinese patients with CKD and health care professionals (HCPs) towards eHealth based (self-management) interventions in general and the Dutch MD intervention in specific.

Methods: We conducted a basic interpretive, cross-sectional qualitative study comprising semi-structured interviews with 11 patients with CKD and 10 HCPs, and 2 focus group discussions with 9 patients with CKD. This study was conducted in the First Affiliated Hospital of Zhengzhou University in China. Data collection continued until data saturation was reached. All data were transcribed verbatim and analyzed using a framework approach.

Results: Three themes emerged: (1) experience with eHealth in CKD (self-management), (2) needs for supporting CKD self-management with the use of eHealth, and (3) adaptation and implementation of the Dutch MD intervention in China. Both patients and HCPs had experience with and solely mentioned eHealth to ‘inform, monitor and track’ as potentially relevant interventions to support CKD self-management, not those to support ‘interaction’ and ‘data utilization’. Factors reported to influence the implementation of CKD eHealth self-management interventions included information barriers (i.e. quality and consistency of the disease-related information obtained via eHealth), perceived trustworthiness and safety of eHealth sources, clinical compatibility and complexity of eHealth, time constraints and eHealth literacy. Moreover, patients and HCPs expressed that eHealth interventions should support CKD self-management by improving the access to reliable and relevant disease related knowledge and optimizing the timeliness and quality of patient and HCPs interactions. Finally, suggestions to adaptation and implementation of the Dutch MD intervention in China were mainly related to improving the intervention functionalities and content of MD such as addressing the complexity of the platform and compatibility with HCPs’ workflows.

Conclusions: The identified perceptions, attitudes and needs towards eHealth self-management interventions in Chinese settings should be considered by researchers and intervention developers to adapt a tailored eHealth self-management intervention for patients with CKD in China. In more detail, future research needs to engage in co-

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creation processes with vulnerable groups during eHealth development and implementation, increase eHealth literacy and credibility of eHealth (information resource), ensure eHealth to be easy to use and well-integrated into HCPs' workflows.

1. Introduction

Chronic kidney disease (CKD) is a severe public health problem [1,2], and has a global prevalence of 9.1% [3,4]. CKD is associated with adverse health outcomes, severe impairments in health-related quality of life [5,6], and considerable health-related and societal cost [7,8]. Interventions promoting adequate CKD self-management (further referred to as self-management) can support patients to improve their health-related quality of life and health outcomes [9–16]. Improving CKD self-management can further reduce disease burden and health care expenditures [14].

Electronic health (eHealth) based interventions are increasingly being developed to support CKD self-management. eHealth, as operationalized by Shaw *et al.* [17], is comprised of three types – '*inform, monitor and track*', '*interaction,*' and '*data utilization*'. eHealth self-management interventions can effectively improve health-related behaviors and health outcomes among patients with CKD [18–20]. Also, such interventions can facilitate healthcare accessibility and efficiency [20], especially in countries that lack strong primary care systems. China is such as country; there is a lack of access to adequate care in rural areas, while the country accounts for 132 million patients with CKD – one fifth of the global burden [21,22].

An extensively studied and effective CKD eHealth self-management intervention is 'Medical Dashboard (MD)' [23–25]. The MD, developed in the Netherlands, enables patients and health care professionals (HCPs) to remotely monitor and track health-related behaviors and disease parameters. The MD could potentially be a great benefit to the (rural) Chinese population.

To successfully implement effective eHealth self-management interventions, it is important to adapt and align these interventions following context characteristics [26,27]. The Health Belief Model (HBM) and the Theory of Planned Behavior (TPB) are two highly cited social psychological theories that focus on individuals' perceptions, attitudes and needs as well as the sociocultural context in which the individual resides [28,29]. Specifically, six HBM constructs (i.e. perceived severity, perceived susceptibility, perceived benefits, perceived barriers, cues to action, and self-efficacy) and three TPB constructs (i.e. attitude, subjective norms, and perceived behavioral control) have been extensively used to explain and predict health-related behaviors [28,29]. As noted in the HBM and TPB, individuals' perceptions (i.e. the organized cognitive representations that individuals have about a subject), attitudes (i.e. an individual's overall evaluation of a subject based on certain perceptions) and needs (i.e. demands and requirements that people require to address their problems) can predict self-management health behaviors and the uptake and acceptability of (eHealth) interventions [28–30]. However, to date, little is known about the perceptions, attitudes and needs towards eHealth interventions supporting CKD self-management, especially for China and other low- and middle-income countries (LMICs).

To inform the adaptation of a tailored eHealth self-management intervention for patients with CKD in China based on the Dutch MD intervention, two qualitative studies were performed. The first examined the perceptions and needs of patients with CKD and HCPs towards CKD self-management in China [31]. This paper describes the results of the second qualitative study and comprises two parts examining:

- Part A: the perceptions, attitudes and needs of patients with CKD and HCPs towards eHealth-based (self-management) interventions in general.
- Part B: the perceptions, attitudes and needs of patients with CKD and HCPs towards the Dutch MD intervention in specific.

2. Material and methods

2.1. Study design

We performed a basic interpretive, cross-sectional qualitative study comprising semi-structured interviews and focus group discussions. The core intervention components, functionalities and supporting screenshots of MD are presented in Textboxes 1 and 2. The methods used differ between patients and HCPs, following group- and context characteristics (see details in Table 1). For instance, focus group discussions could not be held with HCPs as they (1) could not be of duty all at the same time, and (2) follow a tight schedule, and finding a time slot that suited all HCPs would be very difficult. Hence, we conducted face-to-face interviews with HCPs. Moreover, we feel that patients with CKD would be comfortable and encouraged to discuss their perceptions, attitudes and needs towards the Dutch MD intervention in a focus group setting. Hence, we discussed this topic with patients with CKD in focus group discussions. More details on the overarching study have been described elsewhere [32]. We adhered to the Consolidated Criteria for Reporting Qualitative Health Research [33] in this study.

2.2. Study setting, participant and recruitment

Our study was conducted in the First Affiliated Hospital of Zhengzhou University in Henan province, China. Henan is one of the biggest provinces of China, accounting for 9% of the rural Chinese population. In rural areas in Henan, an estimated 16.4% (12 million) of adults suffer from CKD [34]. There is a lack of a strong primary care system in the rural areas in Henan. Because of this, the gatekeeping role of primary care professionals is not fulfilled. Hence, patients self-refer to higher-level health care, mostly based on their ability and willingness to pay. The care for patients with CKD therefore lies almost solely with the HCPs who work in the Department of Nephrology in the city hospital. The Department of Nephrology of the First Affiliated Hospital of Zhengzhou University has five sub-units with approximately 276 beds; more than 60,000 patients with CKD visit the Outpatient Clinic of Department of Nephrology each year. Additionally, as a strong primary care system in (rural) China is lacking, the distance to healthcare facilities is a significant problem for patients with CKD in Henan.

Participants were recruited from January to April 2019. The eligibility criteria for study inclusion of patients with CKD and HCPs are detailed in Table 2. We followed the principles of 'purposive and convenience sampling' [35] to capture a diverse sample during sequential

Table 1
Field methods for research topics.

Method	**Part A:** Perceptions, attitudes and needs towards eHealth based (self-management) interventions for CKD[a] in general		**Part B:** Perceptions, attitudes and needs towards the Dutch Medical Dashboard self-management intervention in specific	
	Patients	HCPs[b]	Patients	HCPs
Semi-structured interviews	X	X		X
Focus group discussions			X	

[a] CKD, chronic kidney disease; [b]HCPs, health care professionals.

recruitment of participants. Two sampling frames were used. The sampling frame for patients comprised the following variables: CKD stage (i.e., Non-dialysis-dependent CKD G1-G3, non-dialysis-dependent CKD G4-G5, home peritoneal dialysis CKD G5), gender (i.e., male, female), and age range. We aimed to recruit an equally distributed sample regarding CKD stage and gender. In China, nurses and nephrologists are the only HCPs providing care to people with CKD. The sampling frame of HCPs comprised the variables: work experience, profession (i.e. nurses, nephrologists), gender, and age. Also, we used snowball sampling [36] to identify additional participants, in which current participants were asked if they knew any other individual who could participate in the study. Patients were recruited via a combined invitation strategy including a) the provision of flyers and b) face-to-face verbal invitations. Also, HCPs were recruited via a combined invitation strategy beginning with: a) an online invitation, and followed by b) the provision of flyers and c) face-to-face verbal invitations. The sample size for the interviews and focus group discussions was not predetermined. Instead, the sample size was determined based on when data saturation was achieved, being the point at which no new or relevant information could be identified through the iterative, preliminary analysis of the data [37]. The detailed information regarding study setting and recruitment procedures is provided elsewhere [32]. Patients and HCPs received a reimbursement (20 RMB of telephone credits) to compensate for their time.

2.3. Research materials and interview content

The interviews and focus group topic lists were developed based on an adapted version of the theoretical framework from the FRESH AIR (Free Respiratory Evaluation and Smoke-exposure reduction by primary Health cAre Integrated gRoups) study [38]. The FRESH AIR implementation framework is based on a combination of the TPB [29] and the HBM [28]. When comparing both models, several overlapping concepts are found, such as attitudes toward behavior in TPB versus perceived benefits in HBM, and perceived control in TPB versus self-efficacy in HBM [39]. Therefore, our framework comprises all explanatory concepts from the TPB (i.e. attitudes, perceived control and subjective norms) [29] and supplements those with concepts of the HBM (i.e. perceived susceptibility and perceived severity) [28] (see Fig. 1). This combination of the TPB and HBM optimizes our ability to elucidate how individuals' perceptions, attitudes and needs can predict health behaviors and the uptake and acceptability of (eHealth) interventions [39].

The combined TPB and HBM framework was used to develop our topic lists (Supplementary material Table 1). For every construct, specific questions were formulated. For instance, to explore attitudes, we asked participants '*To what extent would eHealth help you in managing your disease*?'. The topic lists were refined through research team discussions. In these discussions, research team members reviewed the interview questions to determine if they adequately enquired on the theoretical concepts. Next, members reviewed the language, wording, and order of questions.

- **Part A**: To examine the perceptions, attitudes and needs of patients with CKD and HCPs towards eHealth-based (self-management) interventions in general, patients and HCPs were first asked to name

Textbox 1
Core intervention components and functionalities of Medical Dashboard.

- **Motivational interviewing:** Patients are provided with a one-hour individual motivational interview, which focuses on discussing barriers, benefits, and strategies for self-management; setting personal goals, and strengthening intrinsic motivation and self-efficacy.
- **Education:** Patients are provided with education, a kidney-friendly cookbook, instructions for self-monitoring blood pressure (using a Microlife Watch blood pressure home device), dietary intake (using an online food diary) and 24-hour urinary sodium excretion (using an innovative point-of-care chip device).
- **Self-monitoring**: Patients are instructed to take health measurements at home (e.g. blood pressure, weight and glucose) and enter the results of these measurements via the secure "self-care" website www.bonstat.nl. The measurements entered via this website are linked real-time to the Medical Dashboard interface.
- **Combination of home and hospital measurements in the Medical Dashboard**: The measurements that patients take at home and the measurements performed during hospital visits are visualized jointly in the Medical Dashboard.
- **Online information support**: Patients are provided with online disease-related information, tips and suggestions focusing not only on medical knowledge, but also on how to obtain and sustain social support, refusal skills, medication adherence strategies, physical exercise, healthy eating, smoking cessation and reduced alcohol intake.
- **Personal coaching**: Patients are coupled with one of four personal coaches: three health psychologists and one dietician. Following the self-monitoring measurements, patients are provided with feedback by telephone from their coach or during hospital visits. The discussion focuses on the progression, achievements, barriers and possible solutions of self-management.

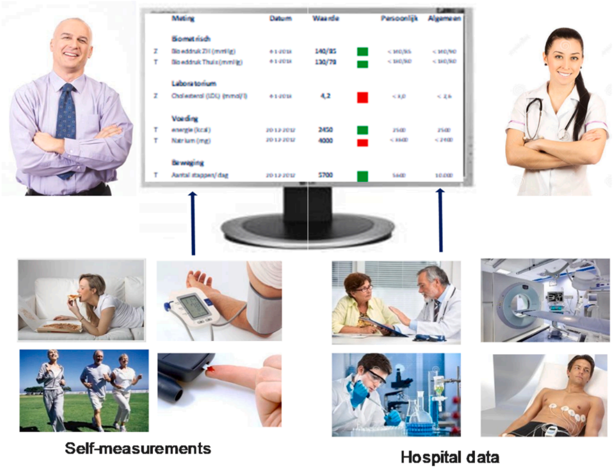
their definition of eHealth. Second, patients and HCPs were informed about the scope of CKD eHealth self-management interventions as defined in our manuscript, namely: 'eHealth technologies ("any information and communication technology designed to deliver or enhance health services and information") applied to facilitate CKD patients' self-management ("the care taken by individuals towards their own health and well-being: it comprises the actions they take to lead a healthy lifestyle; to meet their social, emotional and psychological needs; to care for their long-term condition, and to prevent further illness or accidents")' [40,41]. Following the three types of eHealth as operationalized by Shaw *et al.* [17], we also provided patients and HCPs with related examples (Table 3). Next, patients and HCPs were asked about their perceptions, attitudes and needs towards eHealth-based (self-management) interventions.

- **Part B**: To examine the perceptions, attitudes and needs of patients and HCPs towards the Dutch MD intervention in specific, participants were prompted with translated information and screenshots in

Textbox 2

Core Medical Dashboard intervention print screenshots.

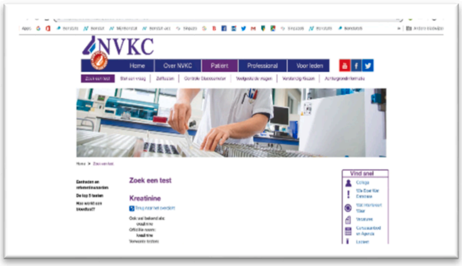
Self-monitoring and combination of home and hospital measurements in the Medical Dashboard:



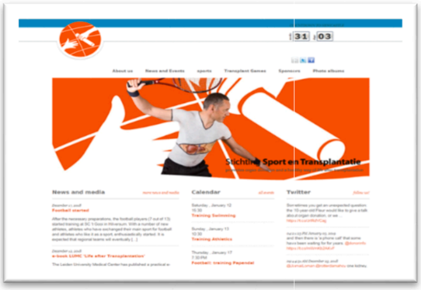
(A) Patients' self-measurements and hospital data are visualized jointly in the Medical Dashboard.

Online information support

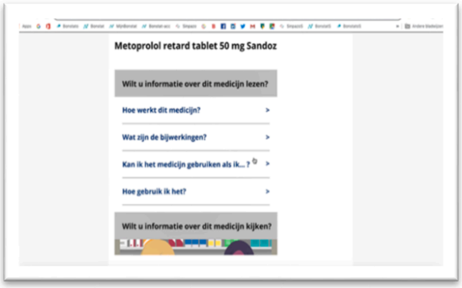
(B) Overview of online information support



(C) Information of laboratory tests (e.g. creatinine)



(D) Information of healthy lifestyle



Metoprolol retard tablet 50 mg Sandoz

Wilt u informatie over dit medicijn lezen?

Hoe werkt dit medicijn? >

Wat zijn de bijwerkingen? >

Kan ik het medicijn gebruiken als ik... ? >

Hoe gebruik ik het? >

Wilt u informatie over dit medicijn kijken?

(E) Information of medication use (e.g. Metoprolol)

Table 2
Eligibility criteria for patients with chronic kidney disease and health care professionals.

Category	Participant eligibility criteria
Inclusion criteria	- Patients: (1) aged over 18 years old; (2) a diagnosis of chronic kidney disease (CKD) with markers of kidney damage or a glomerular filtration rate of$<$60 ml/min/1.73 m^2 persisting for $\geq$ 3 months based on Kidney Disease Improving Global Outcomes (KDIGO) guidelines; (3) all CKD stages (stage G1-G5) following the KDIGO staging of CKD; (4) Chinese speaking. Health care professionals (1) who work in the Department of Nephrology of the First Affiliated Hospital of Zhengzhou University; (2) are able to implement the intervention in their daily practice; (3) Chinese speaking.
Exclusion criteria	- Individuals unable to provide written informed consent and/or use the electronic application due to physical disabilities such as eyesight problems or mental disabilities such as psychosis, personality disorders or schizophrenia (final decision for exclusion to be made by the treating physician); Individuals unable to write or read.

Chinese detailing the intervention content and design features of the MD intervention via a PowerPoint presentation.

A pilot interview was conducted with both a patient and an HCP to evaluate and improve the content, length and understandability of research materials. For instance, based on the pilot results, the first question “How did you feel when received the diagnosis of chronic kidney disease?” was changed to “When did you receive the diagnosis of chronic kidney disease?”, as the pilot patient mentioned that it was stressful to recall the initial diagnosis, and the question ‘got him off guard’. After, more natural probing towards patients’ illness experience and daily disease self-management using eHealth followed. Other key learnings of the pilot interviews are shown in Textbox 3.

2.4. Data collection

One researcher (HS, female, a PhD student focusing on eHealth applications in chronic disease self-management, master’s degree in nursing, expertise in qualitative research) conducted semi-structured interviews and focus group discussions. The interviewer had no contact or relation with any participant before the study. Also, the interviewer was formally trained and had ample experience with qualitative research. To ensure confidentiality and privacy, face-to-face interviews and focus group discussions were performed in a private room in the hospital department. Each topic started with an open-ended question, then follow-up questions, and prompts were used when needed. All semi-structured interviews and focus group discussions were audio-recorded. All audio-taped interviews and focus groups were transcribed verbatim in full in Chinese. Field notes detailing the interview setting, atmosphere, and participants’ non-verbal behaviors enabled richer data analyses. Also, we collected participants’ sociodemographic- and clinical characteristics via the patient medical records. Additionally, sociodemographic characteristics of HCPs were collected.

2.5. Data analysis

A Framework Method [42] was used to guide our qualitative analysis (see details in Textbox 4). Sampling was purposeful and sequential (see methods; Section 2.2). After the first three interviews, a preliminary analysis using the proposed codes was performed, and a data saturation grid [37] was developed to determine if saturation was reached. The data saturation grid consists of a report of the occurrence of themes and codes (displayed in a row) during each interview or focus group

Table 3
The operationalization of types of eHealth.

Types of eHealth	Operationalization in Shaw et al. [17]	Examples provided
Inform, monitor and track	eHealth technologies to observe and study health parameters	
Inform	eHealth to educate	Website for disease knowledge
Monitor and track	eHealth to monitor (un)healthy behavior	Applications to monitor weight or blood pressure
Interaction	eHealth to facilitate communication between all health care participants	Video call for treatment knowledge
Data utilization	eHealth to collect, manage, and research data on health	Electronic health records

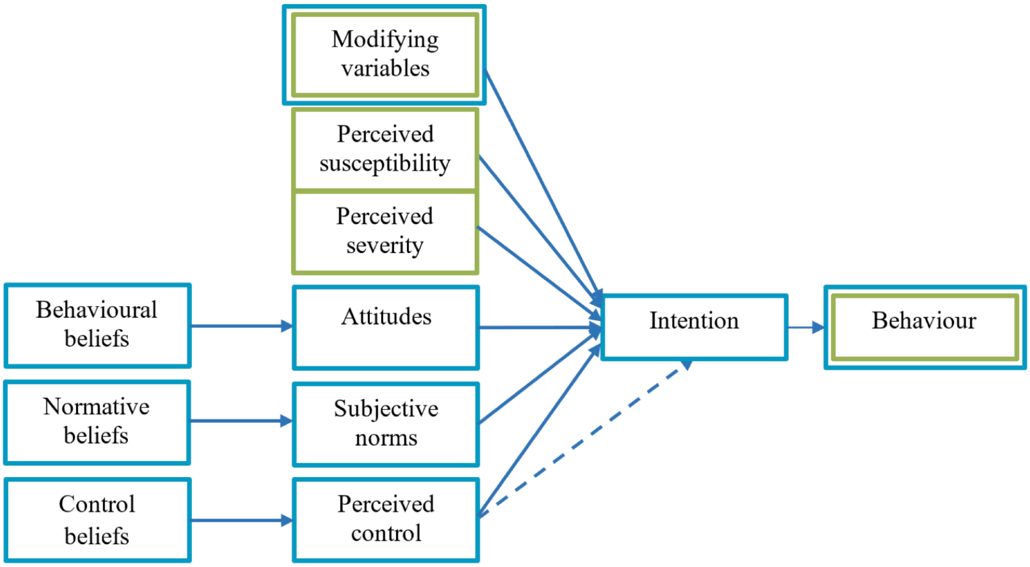


Fig. 1. Adapted version of the theoretical framework of FRESH AIR [38]. A combination of concepts of the Theory of Planned Behavior (blue) and the Health Beliefs Model (green). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Textbox 3
Key learnings of the pilot interviews.

- Beginning with social conversation (‘small talk’) before the interview builds good rapport.
- Participants co-decide on a convenient time and location for the interview.
- Encouragement techniques such as ‘actively acknowledging the participants’ responses can improve interview flow and the interviewer-interviewee relationship.
- The interviewer should be mindful of language differences or difficulties (i.e., local language or mandarin).
- The interviewer should be flexible in the order in which topic list questions are posed, and the flow of the interview is vital.

(displayed in a column) in a tabular format. In the grid, saturation is considered reached when the grid column for the current interview and focus group indicates no new information emerged for that particular theme or code. Recruitment continued until we found that in the 11th patient interview, the second focus group discussion and in the 10th HCP interview, data saturation on all themes and codes was achieved (data saturation table included as supplementary material Tables 2 and 3). A total of 20 patients and 10 HCPs were recruited; 21 semi-structured interviews (11 patients with CKD and 10 HCPs) and 2 focus group discussions with 9 patients were conducted. The codes and results of the preliminary analysis informed further steps of the Framework Method analysis. Data analysis was performed in Chinese by HS and WW and the quotations were translated into English by HS and RK, after analysis.

2.6. Ethics approval and informed consent

This study was approved by the Ethics Committee of the First Affiliated Hospital of Zhengzhou University (reference number 2019-KY-52). All participants provided written informed consent.

3. Results

3.1. Participant, interview and focus group discussion characteristics

A total of 21 semi-structured interviews (11 patients with CKD and 10 HCPs) and 2 focus group discussions with 9 patients were conducted (Tables 4 and 5, supplementary material Table 4).

Three major themes emerged from our data for both patients and

Textbox 4
Framework method approach for data analysis.

Stage A and B: Transcribing and Familiarization
- All audio-taped semi-structured interviews and focus group discussions were anonymized and transcribed verbatim in Chinese. Names and identifiers were removed to protect participant confidentiality. One researcher performed transcription, and another researcher checked transcripts to ensure content accuracy. Before coding, the two researchers independently read transcriptions full text to become familiar with the data.

Stage C: Development of an analytical framework & coding
- Atlas.ti for Windows version 7.5.18 (Scientific Software development, Berlin) was used for data analysis. Initial coding trees were developed based on the theoretical framework developed in our study protocol [32] and the Technology Acceptance Model [30]. The final coding tree was built in two steps. First, the independent coding of three transcripts using the initial coding tree by two researchers was compared, with differences highlighted. Next, differences were discussed in the research team until consensus was reached. After, one researcher (HS) coded all transcripts using the final coding tree; codes were verified by a second researcher (WW).

Stage D: Charting data into the framework matrix
- Data were further reduced by formulating within-cases and cross-cases [43]. Next, data were charted into matrices per research question using Microsoft Excel 2010 and reviewed by all authors. The matrix comprised of one row per participant and one column per code.

Stage E: Interpreting the data
- Themes were generated from codes derived from the data set by reviewing the matrix and making connections within and between participants and codes. Emergent themes were then organized into major themes and subthemes. All themes were discussed among the research team and modified if needed.

Table 4
Participant characteristics: health care professionals.

Characteristics	Value (N = 10)
Age (years), mean (SD)	33 (6.1)
Age (years), n (%)	
21–30	4 (40)
31–40	5 (50)
41–50	1 (10)
Gender, n (%)	
Female	9 (90)
Job occupation, n (%)	
Nurse	7 (70)
Nephrologist	3 (30)
Marital status, n (%)	
Never married	2 (20)
Married	8 (80)
Highest level of education completed, n (%)	
Bachelor's degree	5 (50)
Master's degree	3 (30)
Doctoral degree	2 (20)
Years of work experience in medical practice, n (%)	
<5	2 (20)
5–10	3 (30)
>10	5 (50)
Years of work experience in nephrology practice, n (%)	
<5	3 (30)
5–10	3 (30)
>10	4 (40)

Table 5
Participant characteristics: patients with chronic kidney disease.

Characteristics	Face to face interview (n = 11)	Focus group discussion (n = 9)
Age (years), mean (SD)	38.9 (9.6)	43.3 (13.2)
Age category (years), n (%)		
18–28	1 (9)	1 (11)
29–39	4 (36)	1 (11)
40–50	4 (36)	3 (33)
51–61	2 (19)	3 (33)
>61	0 (0)	1 (11)
Gender, n (%)		
Female	6 (54)	5 (56)
Marital status, n (%)		
Never married	1 (9)	1 (11)
Married	9 (82)	8 (89)
Divorced	1 (9)	0 (0)
Highest level of education completed, n (%)		
≤Primary school	3 (27)	5 (56)
Middle school	3 (27)	2 (22)
≥High school graduate	5 (46)	2 (22)
Employment status, n (%)		
Employed (full time & part-time)	2 (18)	2 (22)
Not employed	7 (64)	2 (22)
Farming	0 (0)	4 (45)
Student	1 (9)	1 (11)
Retired	1 (9)	0 (0)
Time since CKD[a] diagnosis, n (%)		
<1 year	5 (46)	7 (78)
1–5 years	3 (27)	2 (22)
>5 years	3 (27)	0 (0)
Current CKD stage, n (%)		
Non-dialysis-dependent CKD G1-G3	5 (46)	6 (67)
Non-dialysis-dependent CKD G4-G5	3 (27)	3 (33)
Home peritoneal dialysis CKD G5	3 (27)	0 (0)

[a] CKD, chronic kidney disease.

HCPs (Part A: Theme 1–2; Part B: Theme 3; Fig. 2). Themes and subthemes are described in the following sections; illustrative quotations (Tables 6-8) and frequencies are provided.

3.2. Theme 1: Experience with eHealth in CKD (self-management)

3.2.1. Views of eHealth in general (patients and HCPs)

When asking patients and HCPs about their definition of eHealth, all of them had heard about eHealth. Patients described eHealth as the technology used to educate, monitor (un)healthy behaviors, and facilitate patients' and HCPs' communication. Also, seven of 21 (7/21; interviews) patients and HCPs largely named examples of eHealth related to telemedicine (quote 1).

eHealth, as operationalized by Shaw et al. [17], is comprised of three types - '*inform, monitor and track*', '*interaction*,' and '*data utilization*' (Table 3). Around 76 percent of patients and HCPs named they used eHealth to '*inform*' and '*monitor and track*' (16/21; interviews). Other types of eHealth such as those facilitating '*interaction*' and '*data utilization*' were used by less than 10 percent of patients and HCPs (2/21; interviews).

3.2.2. Experience with eHealth use (patients and HCPs)

For the eHealth to '*inform*', more than half of patients cited they used their mobile phones to obtain disease-related information through search engines (9/11; interviews) such as Baidu (a Chinese search engine) (quote 2). Patients also mentioned the benefits of eHealth use, mostly related to highly improved access to 'easily understandable information' (quote 3). More than half of HCPs mentioned using eHealth to provide health education such as medical advice on symptom management to patients. For instance, HCPs named they used mobile phone applications for providing health education (7/10; interviews), predominantly WeChat (an online social network and chat app from the Chinese company Tencent) (6/10; interviews). Additionally, when eHealth technology was used by HCPs to 'inform', they cited that it benefited their medical practice (7/11; interviews); among which 'saving time on patients' health education' (quote 4) and 'improving the ability to illustrate practical medical advice with videos or animations' (quote 5).

About one-third of patients mentioned the use of eHealth to '*monitor and track*' health parameters (4/11; interviews). For example, those receiving peritoneal dialysis mentioned that they downloaded applications on their smartphone to self-monitor physiological parameters (e.g. blood pressure). Almost half of the patients also mentioned benefits of app-based self-monitoring, mostly related to 'ease of use' in comparison to tracking their measurements on paper (quote 6). Additionally, HCPs mentioned that they anticipated that improved self-monitoring by patients improves patients' health behaviors, and also helped HCPs to provide accurate medical advice, based on the changes in parameters or symptoms tracked (5/10; interviews) (quote 7).

3.2.3. (anticipated) Barriers to using eHealth technology

3.2.3.1. Information barriers (patients and HCPs). More than half of patients (7/11; interviews) and HCPs (7/10; interviews) cited barriers related to the quality and consistency of the disease-related information obtained via eHealth; for instance, information is 'not practical and detailed', and sometimes is 'inconsistent when consulting different websites or apps' (quotes 8 and 9).

3.2.3.2. Trustworthiness and safety (patients and HCPs). Patients (6/11; interviews) and HCPs (5/10; interviews) noted perceived barriers related to trustworthiness and safety of eHealth resources. For instance, patients expressed concerns about whether websites contained accurate information (quote 10). HCPs mentioned that they were reluctant to provide medical advice in online consultations, as they were concerned regarding the reliability of information patients provided online (quote 11).

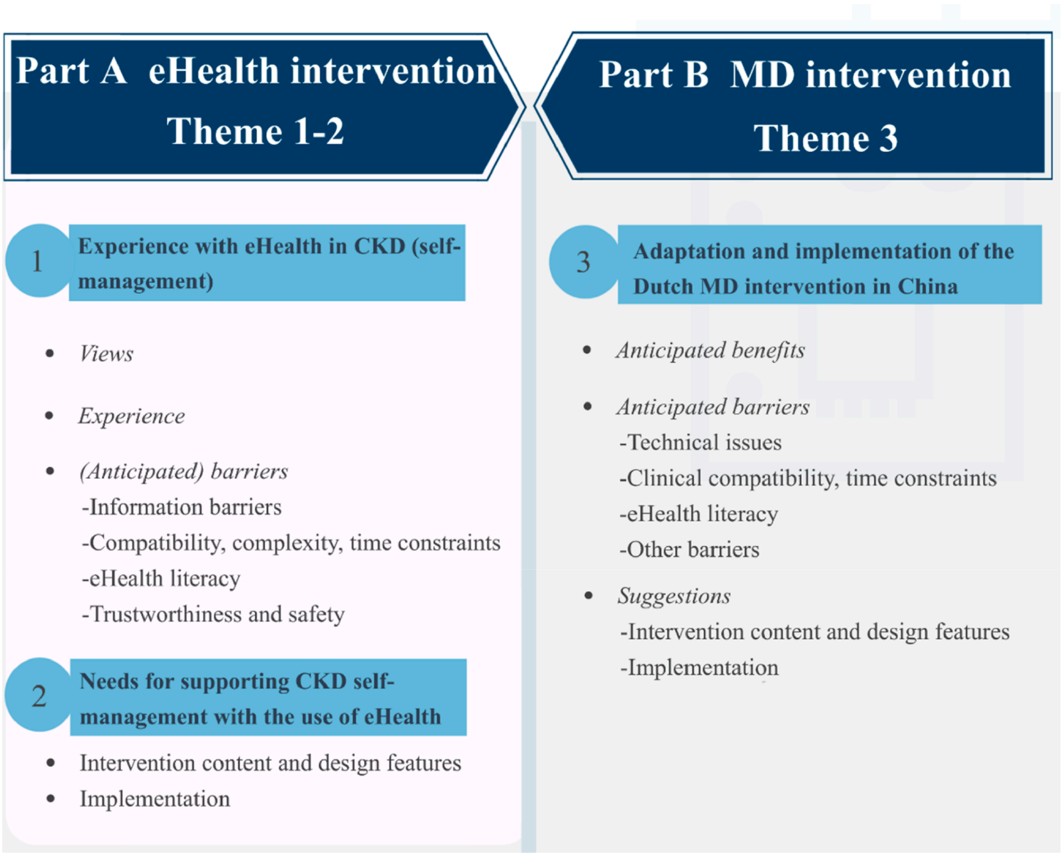


Fig. 2. Overview of themes and subthemes from the analysis. MD: Medical Dashboard.

3.2.3.3. Compatibility, complexity of eHealth and time constraints (HCPs). Half of the HCPs mentioned the ‘complexity of eHealth’ and ‘a lack of compatibility of eHealth with their workload and scope of practice’ as barriers (5/10; interviews). Almost half of HCPs mentioned that the extra tasks and burden of eHealth increased their work stress (4/10; interviews) (quote 12).

3.2.3.4. eHealth literacy (HCPs). Almost half of HCPs mentioned low levels of patients’ eHealth literacy – little eHealth experience, knowledge, and skills as a barrier towards eHealth use (4/10; interviews) (quote 13).

3.3. Theme 2: Needs for supporting CKD self-management with the use of eHealth

3.3.1. Intervention content and design features (patients and HCPs)

Patients (4/11; interviews) and HCPs (6/10; interviews) expressed a need for eHealth as a medium to improve access to disease-related knowledge that is relevant and conducive to the specific patients’ health needs (quotes 14 and 15). Additionally, almost half of patients mentioned a need for eHealth to support their communication with HCPs outside of clinical visits (4/11; interviews), enabling more individualized support and follow-up on their physical symptoms in between consultations (quotes 16 and 17).

For design features of eHealth, both patients and HCPs preferred the use of mobile phone apps instead of personal computers for CKD self-management, as they found that apps were more easily accessible. To facilitate the transfer of disease-related knowledge, half of the HCPs mentioned that animations or videos without medical terminology should be included to support spoken words or text in eHealth interventions (5/10; interviews). Details are provided in supplementary material Table 5.

3.3.2. Implementation and practicality (patients)

Almost half of patients mentioned that the high perceived credibility of eHealth interventions was essential for successful uptake and implementation (4/11; interviews). Specifically, patients mentioned that if interventions were developed by credible eHealth developers such as the government or hospitals, it would facilitate their eHealth use. In more detail, patients mentioned that this would ensure them that the information came from a reputable and trusted source (quote 18), as they described (their) HCPs as trusted and familiar.

3.4. Theme 3: Adaptation and implementation of the Dutch MD intervention in China

3.4.1. Anticipated benefits of MD (patients and HCPs)

In the focus group discussions, patients noted that the ‘online information support’ component of MD could improve their access to trusted disease-related knowledge; It would enable them to find information quickly and address their questions without a clinic visit or contacting their HCP (quote 19). Also, almost half of HCPs cited the possible benefits of this component (4/10; interviews), especially related to ‘trustworthiness and safety of the information sources’ and “easy access to lab results- and related knowledge to educate patients’ and ‘possibilities to improve treatment adherence’ (quotes 20 and 21).

For the ‘self-monitoring’ and ‘combination of home and hospital measurements in the MD’ components, in the focus group discussions, patients valued the quick access to their laboratory test results and health information before a clinic visit (quote 22). Also, patients mentioned that HCPs’ access to their self-monitored health indicators made them feel being ‘looked after’, and that they appreciated the possibility provided by MD to get in touch with HCPs if their health parameters were deteriorating (quote 23). More than half of HCPs also cited possible benefits of these two MD components (8/10; interviews),

Table 6
Illustrative quotes related to theme 1.

Themes and Subthemes	Illustrative quotes
Theme 1: Experience with eHealth in CKD (self-management)	
Subtheme 1: Views of eHealth in general	
– Treatment knowledge via video calls	**Quote 1**: eHealth is that […] I can ask HCPs questions about treatment and diagnosis [of CKD] […] with remote video calls [with the HCPs]. (Patient 4, male, 37y, CKD 2; interviews)
Subtheme 2: Experience with eHealth use	
– Disease-related knowledge via search engines	**Quote 2**: I often search [information of] this [chronic kidney] disease using Baidu. […] the treatment or what precautions I need to care about. (Patient 5, male, 35y, CKD G3; interviews)
– Disease-related knowledge via eHealth	**Quote 3:** The articles HCPs posted are practical. […] I can have a general understanding of the disease. (Patient 8, female, 45y, CKD G1; interviews)
– Medical education via videos	**Quote 4**: The process of patients' asking [medical] questions can be simplified. […] When patients asked for information, I can show them videos, which is easy. (HCP5, female, 34y; interviews)
– Treatment knowledge via videos	**Quote 5**: The animation and videos we provided during routine care [.......] The content can help patients easily understand the diet restrictions and medication use. (HCP5, female, 34y; interviews)
– Monitoring parameters via eHealth applications	**Quote 6**: [Monitoring parameters in] the app is easier and much more convenient than recording them in a notebook. (Patient 7, female, 32y, CKD G5 with peritoneal dialysis; interviews)
– Therapy plan development via app	**Quote 7:** Patients put their information into the apps. Then, we can develop the therapy plan that suits them better according to their status at home. (HCP6, female, 33y; interviews)
Subtheme 3: (anticipated) Barriers to using eHealth technology	
– Information barrier: too little detail	**Quote 8**: The information in Baidu or other websites is not detailed. (HCP9, female, 39y; interviews)
– Information barrier: conflicting and not detailed	**Quote 9**: Online knowledge of food with high potassium is not detailed and sometimes conflicting. (Patient 6, male, 34y, CKD G5 not dialysis; interviews)
– Information barrier: incorrectness	**Quote 10**: I cannot completely trust the information online. Maybe it is not correct. (Patient 8, female, 45y, CKD G1; interviews).
– Trustworthiness and safety: reliability	**Quote 11**: Although patients submit some measurements online, the data may be not accurately measured […] Providing medical advice online is risky. (HCP6, female, 33y; interviews).
– Complexity of eHealth: increased work burden	**Quote 12**: We now have an app for helping monitor patients' data. […] However, we need to submit medical data in this app. […] (HCP9, female, 39y; interviews)
– Low eHealth literacy level	**Quote 13**: Some patients do not know how to use the internet, […] and some [patients] find it complicated to submit data online. (HCP2, female, 30y; interviews)

CKD, chronic kidney disease; HCP: health care provider.

Table 7
Illustrative quotes related to theme 2.

Themes and Subthemes	Illustrative quotes
Theme 2: Needs for supporting CKD self-management with the use of eHealth	
Subtheme 1: Intervention content and design features	
– Disease knowledge provide via videos	**Quote 14**: If we can make some videos in the department [of nephrology], the patients will learn more [about disease], […] such as the food they should eat. (HCP5, female, 34y; interviews)
– Tailored disease knowledge	**Quote 15**: I think that it can be better if there are some detailed guidance and those are tailored for me, not for everyone. (Patient 11, female, 51y, CKD G3; interviews)
– Tailored online consultation	**Quote 16**: I hope that […] I can get a reply tailored to my condition through online consultation. […] (Patient 2, female, 18y, CKD G1; interviews)
– Tailored communication with HCPs online	**Quote 17:** It is good if patients can talk to the doctor online if they have minor problems [related to disease] at home, […] such as getting a cold. (Patient 8, female, 45y, CKD G1; interviews)
Subtheme 2: Implementation and practicality	
– Perceived credibility	**Quote 18**: eHealth applications need to be certified and trusted. For example, WeChat is trusted by everyone. […] Also, the experts who register in the applications need to be trusted, […] such as with a detailed introduction of their medical background. (Patient 4, male, 37y, CKD G2; interviews)

CKD, chronic kidney disease; HCP: health care provider.

as they may help them to track patients' home measurements (quote 24). Also, HCPs stated that they may be able to provide a better quality of care and guidance during clinical appointments when they could review the patients' data collected before their clinic visit (quote 25).

3.4.2. Anticipated barriers of MD use

3.4.2.1. Clinical compatibility and time constraints (HCPs). Almost half of HCPs cited barriers related to the compatibility of MD with their clinical work and time constraints (4/10; interviews). HCPs mentioned that the use of MD would lead to an additional workload (e.g. reviewing patients' electronic health records continuously) and that it would be difficult to incorporate the intervention into their current work schedule (quote 26).

3.4.2.2. Technical issues (HCPs). Almost half of HCPs named barriers related to the availability and use of technology necessary to implement MD (4/10; interviews); for instance, a lack of computers and wireless internet connection at home (quote 27).

3.4.2.3. eHealth literacy (HCPs). More than half of HCPs mentioned that patients' eHealth literacy might be a barrier to the implementation of MD in China (6/10; interviews) (quote 28).

3.4.2.4. Other barriers related to features of MD (patients and HCPs). More than half of HCPs voiced concerns on the potential validity of the electronic data submitted by patients in MD (6/10; interviews) (quote 29). More specifically, HCPs mentioned they anticipate patients with a lower educational level and those not familiar with device use may upload 'invalid measurements'. Also, HCPs mentioned a 'possible reluctance of patients to submit abnormal data', For instance, HCPs named that some patients would be worried that if they submit abnormal data they would be asked to come to the hospital for a check-up, providing them with a financial burden. Additionally, patients and HCPs mentioned that the computer-based version of MD was difficult to use as it was different from patients' previous experience with eHealth technology (i.e. smart phone). For instance, the need to login to the MD via a separate website was mentioned (quote 30).

3.4.3. Suggestions for adaption and implementation of MD based self-management intervention in China

3.4.3.1. Recommendation on design and intervention content (patients and HCPs). Patients and HCPs mentioned potential improvements for both the design and intervention content of MD (detailed in Textbox 5, quotes 33–40). Also, HCPs recommended design adaptations for MD to ensure that the intervention is easy to use by patients, fits well with and

Table 8
Illustrative quotes related to theme 3.

Themes and Subthemes	Illustrative quotes
Theme 3: Adaptation and implementation of the Dutch MD intervention in China	
Subtheme 1: Anticipated benefits of MD	
– Disease-related knowledge	**Quote 19**: It will be great if I know the meaning of each test indicator online. (Patient 14, female, 52y, CKD G4; focus group 2)
– Trustworthy and safe disease-related knowledge	**Quote 20**: The health education [in Medical Dashboard] is safe. The doctors have checked the content. Patients can read the information according to their needs. (HCP2, female, 30y; interviews)
– Easy access to disease-related knowledge	**Quote 21**: Patients can check directly online about how to use the medication. This can [help] improve their [treatment] adherence. (HCP1, female, 31y; interviews)
– Quick access to laboratory tests	**Quote 22**: It will be convenient if I can see my laboratory tests directly. […] Especially when doctors are too busy to provide test results. (Patient 15, female, 41y, CKD G4; focus group 2)
– Doctors' access to disease status	**Quote 23**: Doctors can know our [disease] status at home. We can communicate with doctors directly online. (Patient 20, female, 43y, CKD G2; focus group 1)
– Tracking patients' home measurements	**Quote 24**: There can be continuous care and follow-up if we can see patients' home measurements. (HCP5, female, 34y; interviews)
– Better quality of care	**Quote 25**: Doctors can provide specific treatment plans according to patients' status at home, such as some medication use. (HCP2, female, 30y; interviews)
Subtheme 2: Anticipated barriers of MD use	
– Additional work burden	**Quote 26**: It will lead to extra work burden and costs a lot of time […] (HCP6, female, 33y; interviews)
– Availability and use of technology	**Quote 27**: It seems difficult for [patients in] rural areas [to use Medical Dashboard]. Many patients do not have devices to measure blood pressure. (HCP1, female, 31y; interviews)
– Patients' eHealth literacy	**Quote 28**: Some patients could be unfamiliar with the use [of Medical Dashboard] and this will affect the implementation. (HCP4, female, 35y; interviews)
– Validity of patient - provided data	**Quote 29**: In Henan, most patients have a lower educational level. if patients are not familiar with how to use the device for monitoring, the data may not be correctly uploaded by patients. Also, for patients with lower economic status, some patients may not upload data if the values are abnormal, because the doctors may call them to come to the hospital for a check-up, which will cost money. (HCP2, female, 30y; interviews)
– Previous use of technology	**Quote 30**: I always use the smartphone to get a call or read the news. It is difficult if I need to enter websites. (Patient 12, male, 62y, CKD G3; focus group 2)
Subtheme 3: Suggestions for adaption and implementation of MD based self-management intervention in China	
– Ease of use	**Quote 31**: This platform must be simple to use and convenient in practice. (HCP8, male, 46y; interviews)
– Tailored eHealth education	**Quote 32**: It is essential to teach patients to conduct the measurements in a correct way to improve the accuracy of the value they measured. (HCP5, female, 34y; interviews)

CKD, chronic kidney disease; HCP: health care provider; MD: Medical Dashboard.

supports their clinical workflows (quote 31).

3.4.3.2. Implementation strategies: Instruction and educational meetings (HCPs). Almost half of HCPs named the necessity to educate patients on the correct use and potential benefits of MD (4/10; interviews). In particular, HCPs mentioned the importance to clearly instruct patients on how to correctly measure health-related indicators and upload their health measurements at home (quote 32).

4. Discussion

4.1. Main findings

We examined the perceptions, attitudes and needs of Chinese patients with CKD and HCPs towards eHealth self-management interventions. Both patients and HCPs expressed (potential) benefits for CKD eHealth self-management interventions to '*inform, monitor and track*'. Interventions to support '*interaction*' and '*data utilization*' were not frequently mentioned. Factors reported influencing the implementation of CKD eHealth self-management interventions included information barriers (i.e. quality and consistency of the disease-related information obtained via eHealth), trustworthiness and safety of eHealth resources, clinical compatibility and complexity of eHealth, time constraints and eHealth literacy. Suggestions were provided to improve the MD intervention functionalities and content, mainly related to addressing the complexity of the platform and compatibility with HCPs' workflows.

4.2. The understanding and potential benefit of eHealth

Our finding that eHealth is solely mentioned to '*inform, monitor and track*' as potentially relevant CKD self-management interventions underlines the importance of education on functionalities and possibilities of eHealth before (co)designing and implementing eHealth interventions; for instance, increasing educational activities of simulation exercises and real-life practice [44]. Moreover, patients and HCPs should be made aware of the possible benefits but also pitfalls of eHealth, to promote informed decisions on intervention adoption and ownership [44].

4.3. Barriers related to implementation of eHealth

Barriers reported were frequently related to the credibility of the information provided via eHealth interventions. This finding indicates that perceived trustworthiness of an information source may play an important role in implementation decision making; the process of evidence informed decision-making [45] regarding intervention design and implementation. For China, to optimize the perceived trustworthiness of an eHealth application, our results suggest adding a sign of approval from a government health agency, and including video statements on intervention quality and usability from familiar HCPs. Several reasons may explain why, especially for the Chinese settings, barriers related to credibility are so important. First, patients with CKD in our study expressed a need for an online information platform established by the government or hospital. These needs are in line with the current paternalistic patient-HCP relationship in CKD self-management in China [31]; HCPs are often perceived as the trusted and familiar sources of health information by patients with CKD. However, the eHealth information platforms used by patients and HCPs in China are mostly developed by commercial eHealth companies, which know more about the commercial interest of technologies than about primary health care (e.g. staff working patterns, practice management), and could hence be considered less 'credible developers'. Second, there is a lack of uniform quality controls and standards on the accuracy of diverse online information in China. Also, patients with low eHealth literacy could not

Textbox 5

A summary of needs towards improvement of Medical Dashboard.

Patient & HCP

- Delivery of MD intervention via smart mobile phone apps

  Quote 33: In Henan, most patients have lower education levels. If it is limited to the computer [as an intervention delivery medium], fewer people will use it [...] they more likely will use mobile phones because almost every patient has a mobile phone. (HCP2, female, 30y; interviews)
- Providing tailored CKD information support

  Quote 34: When doctors provided education on disease information, it is too general, and some information is not suitable for my situation. (Patient 12, male, 62y, CKD G3; focus group 2)
- Peer support

  Quote 35: A patient could know more than doctors about how to live a good life every day. It may be important to develop some peer support in the Medical Dashboard. (HCP2, female, 30y; interviews)
- A psychological module for patients

  Quote 36: No one wants to get sick. The mood is particularly important, in addition to those necessary [parameters] such as blood pressure, weight, diet or drugs. It is important to develop a psychological module to add some success stories of disease coping, thereby encouraging patients and helping them share feelings. (P16, male, 19y, CKD G1; focus group 1)
- Video or voice call to support interactions between HCPs and patients

  Quote 37: I think it would be better if patients could contact the HCPs online. Because patients may have lots of questions on disease, they might be more willing to consult HCPs if they can have video or voice calls with HCPs. (HCP10, female, 25y; interviews)
- Reminders sent to HCPs when patients-entered data is abnormal

  Quote 38: It would be excellent that if patients have abnormal values, the Medical Dashboard can send alerts to HCPs. Then, the HCPs can quickly provide patients with guidance from a distance, which can also help patients manage themselves. (HCP3, female, 27y; interviews)

HCP

- The wireless tracker in a mobile application to automatically collect measurements

  Quote 39: If there is a wearable device connected to Medical Dashboard, it is much easier and convenient than a traditional way by uploading measurements by individuals. (HCP8, male, 46y; interviews)
- A user interface platform in a mobile application to visualize data and to review progress

  Quote 40: If all data collected by Medical Dashboard can be reviewed by HCPs with using a user interface platform in a mobile application, it will help HCPs provide better clinical care. (HCP2, female, 30y; interviews)

accurately evaluate the quality of eHealth information resources. Hence, a reliable, trustworthy, and literacy-appropriate information source such as a national and trustworthy health education online platform [46] should be developed, thereby ensuring that trustworthy medical information is available for patients with CKD. Also, tailored education and training are required and should be updated for patients to obtain sufficient knowledge of eHealth intervention and digital competency [47].

HCPs found it difficult to integrate eHealth interventions into their daily working routines in the past. This finding is corroborated by previous research [48], underlining the importance of assessing intervention-workflow compatibility (e.g. staff working patterns, practice management) before and during the development and implementation of eHealth interventions [49]. To increase the clinical compatibility of eHealth interventions, such interventions should partially replace existing care elements [50], instead of adding elements to care. Also, to ensure that the eHealth application is time-saving, eHealth functionalities must be simple and easy to use and eHealth navigation must be clear.

Furthermore, patients' low eHealth literacy [51] is commonly forwarded as a potential barrier to implementation by HCPs. People's level of eHealth literacy can be influenced by environmental and societal factors such as different experiences with eHealth tools, patient age, and education level [52]. Without sufficient consideration of these vulnerable groups, eHealth could increase health inequalities [53]. To reduce possible health inequalities, we advise to incorporate elements to improve eHealth literacy in eHealth interventions. Moreover, future researchers and eHealth intervention developers may engage in co-creation processes with vulnerable groups to tailor interventions to the users' level of (eHealth) literacy. Also, as face-to-face contact remains necessary to optimize medical care, adherence and treatment outcomes [54], it is important to conduct 'blended care' [55]; combining eHealth with face-to-face support to provide people with personal assistance and coaching on eHealth use.

4.4. Comparison with prior research on patient needs towards eHealth and self-management in CKD

Our findings on patient needs towards eHealth interventions and self-management in the Chinese setting were to some degree comparable to the results of similar studies performed in western contexts. We found that patients reacted positively to the idea of using eHealth to provide easy access to disease-related information and improve information sources. This finding is consistent with previous literature [56–60]. Additionally, our finding that patients were generally in favor of using eHealth as a medium to access their health records and support interaction with their HCPs was corroborated by other research [59,61].

However, several of the needs of patients we identified differ from previous findings of studies mostly conducted in western settings. First, the importance of credibility was strongly emphasized by patients for a successful implementation of eHealth self-management interventions. For instance, our findings show a distrust of patients towards eHealth developed by commercial companies; patients expressed they only trusted eHealth developed by their government or hospital. This finding is not reflected in previous literature on the development of user-centered eHealth application [62]. Hence, for eHealth implementation to be successful in the Chinese context, we argue that a strong and visible connection with government bodies or care facilities is warranted. Second, compared to previous research [59,61] our findings highlight a more prominent importance of eHealth to facilitate interaction between patients and HCPs both in primary care and hospitals. In China, the care for patients with CKD relies heavily on HCPs who work in the Department of Nephrology. As a strong primary care system in (rural) China is lacking, the distance to healthcare facilities is a significant problem for patients with CKD, and interaction via eHealth is therefore of great importance to enable access to care [63]. Finally, patients mentioned they preferred the use of mobile phone apps over web-based mediums. This is not as frequently mentioned in previous research on patients' needs towards eHealth. China has 1.3 billion mobile phone users (penetration rate of 90%) [64–67], whereas, in contrast to most western countries, a significantly lower percentage has access to a personal computer [68]. Hence, eHealth via mobile phone is most likely the best option for wide-scaled delivery of CKD self-management interventions in Chinese settings.

4.5. MD specification development

In general, patients and HCPs indicated that the Dutch MD would be helpful to support CKD self-management, especially the components of online information support, self-monitoring and the combined home- and hospital health measurements. Considering the anticipated barriers and needs reported, some surface level adaptations [69] should be made to improve the fit of MD with Chinese settings. Surface-level adaptations involve customizing intervention content, messages, and approaches to the observable cultural characteristics of the local patient population to enhance the intervention's appeal, receptivity, and feasibility [70]. In our case, four surface adaptations may include: (1) providing more basic and in-depth CKD information translated in Chinese, (2) providing video- or voice call options on the dashboard to support interactions with HCPs, and (3) extending the intervention delivery medium to a mobile phone app, combined with a wireless tracker to automatically collect measurements, and (4) a user interface platform to visualize data and to enable progress review. Furthermore, participants expressed a "one-size-fits-all" approach would not motivate patients sufficiently; The need to add personalized features was emphasized, such as visual aids, pictograms, and customized videos. For instance, videos covering tailored information about CKD and its treatment, such as a video on fluid restrictions and dialysis procedure for patients with end stage renal disease, or a video on 'living with CKD' (e.g. successful examples of self-management) for patients who just received a CKD diagnosis. Moreover, to ensure the continued effectiveness of MD, the core self-management intervention components that underly its effectivity, such as self-monitoring, should not be changed [69].

4.6. Transferability, implications and recommendations

The (anticipated) barriers mentioned by patients and HCPs were similar between eHealth (self-management) interventions in general and Dutch MD intervention in specific. It underlines the importance of exploring the previous eHealth use experience of end users, which could influence their perceptions, attitudes and needs towards eHealth interventions. Also, the methodological approach and findings of our study can be relevant for Chinese settings as well as other countries sharing similar contextual characteristics. These similar contextual characteristics include the lack of a strong primary care system, a long distance to healthcare facilities, a limited understanding and knowledge of CKD (self-management), a more prominent paternalistic patient-HCP relationship, combined with the wide-scale use of (internet) mobile phone applications. The SETTING-tool (Setting-Exploration-Treasure-Trail-to-Inform-ImplementatioN-strateGies) used for mapping local contexts for (lung) health interventions in diverse low-resource settings [71] details how interventions can be tailored for countries that share similar contextual characteristics. The accessibility of CKD care remains suboptimal due to the long distance to healthcare facilities. One solution for accessibility may be the so-called 'internet hospitals' that allow patients to receive high-quality care from a top-tier hospital from either their own home or a local clinic. Moreover, these hospitals may play a crucial role in the development of primary health care [66]. To improve the understanding of CKD self-management of patients and HCPs, it is essential to first focus on education about self-management itself, thereby aiming to improve patient health literacy. The paternalistic relationship identified can be valuable and even essential to improving health outcomes and treatment adherence in some cultural contexts, for instance, if patients prefer a paternalistic approach over autonomy. Hence, we advise to make use of the paternalistic guidance by HCPs to help build a strong belief on importance and potential benefits of self-management [72].

Furthermore, several challenges need to be considered when tailoring Dutch MD to the Chinese context. First, especially in rural China, we found that even a basic understanding of medical topics and in specific self-management behavior was lacking. Knowledge on self-management was also lacking in HCPs [31]. This underlines the need for tailored education and training on the core concepts of self-management interventions before intervention implementation can commence. Second, a strong primary care system is lacking in (rural) China. Hence, the care for patients with CKD relies heavily on HCPs who work in the hospitals' Department of Nephrology. These HCPs have very little time for consultations- even less time than HCPs in western countries. Consequently, it is even more challenging in this context to integrate conversations on self-management in regular consultations. Before the Dutch MD can be implemented, it is necessary to explore possibilities to optimize the time available, for instance by considering 'role enhancement'; educating nurses to provide specialized care covering self-management consultations and support. Also, instead of only changing individual attitudes, knowledge, or behavior, we found indication that especially for the Chinese setting, a whole-system change is needed. In comparison to most western countries, Chinese society is more collective. Good relations with family members and the community the patient resides in are of utmost importance. Therefore, for instance, to heed patients' habits of high-salt eating, caregivers need to be informed, in agreement and ensure family meals meet the requirements of a low-salt diet. Additionally, adaptations of educational self-management materials, such as informative videos, are needed to ensure that these materials are relevant to individual patients' daily life in Chinese settings.

The following lessons learned from our study may support future research on intervention adaptation. First, instead of a "one-size-fits-all" approach for the implementation of eHealth self-management interventions, it is essential to map and thoroughly understand the context-specific factors influencing implementation. Specific focus should be on vulnerable groups and eHealth illiteracy to avoid an increase in health inequality. Second, stakeholder involvement via co-creation processes is a prerequisite for the successful development and implementation of eHealth. Third, when translating interventions to other contexts, developers should adapt the intervention to local contextual characteristics, as opposed to try and change contextual characteristics (e.g. time available, patient-HCP relationships) in the local setting.

4.7. Strengths and limitations

To our knowledge, this is the first study to explore the perceptions, attitudes and needs of patients with CKD and HCPs towards eHealth self-management interventions in Chinese settings. Our study has several strengths. First, a diverse sample (e.g. CKD stage) we captured ensures that our findings reflected the view of a wide variety of patients with CKD. Second, to improve the robustness of our research, the data collection process and the (preliminary) analysis were performed by two team members (HS, WW) to optimize consistency. Also, the framework approach to data analysis allowed data to be compared through the formulation of narratives (in-depth focus) and within- and cross-case comparisons (comparative focus).

Nevertheless, there are also limitations. First, the HCPs who provided CKD care in the institution were predominantly female. The HCP group interviewed may not have been representative of all HCPs in Nephrology practice. This selection bias might be caused by the fact that participants who were more positive towards self-management were more likely to participate in our study. However, the number of barriers identified in this study might indicate that this bias has remained limited. Additionally, this study was performed in only one setting in China. Also, solely patients under 65 years of age participated in our study. Further research is needed to evaluate whether our findings are relevant to other contexts and older people.

4.8. Conclusions

The limited knowledge on the functionalities of eHealth underlines the need for tailored education and training before and during intervention design and implementation. To optimize the implementation of Dutch MD eHealth self-management interventions for patients with CKD in China, future researchers and intervention developers should ensure eHealth to be easy to use and well-integrated into HCPs' workflows, engage in co-creation processes with vulnerable groups during eHealth development and implementation, and tailor interventions to the users' level of (eHealth) literacy.

5. Summary points

What was already known on the topic

- eHealth self-management interventions such as an example of an extensively studied and effective Medical Dashboard intervention are urgently needed to improve health and wellbeing of patients with chronic kidney disease by improving the quality of clinical (primary) care in China, in which around one fifth of the global burden of chronic kidney disease occurs. To successfully adapt and tailor effective eHealth self-management interventions for patients with chronic kidney disease in China, it is important to align the interventions with key users' needs and perceptions. Little knowledge is available on perceptions, attitudes and needs towards eHealth interventions supporting chronic kidney disease self-management, especially for China and other low- and middle-income countries.
- What this study added to our knowledge
- Instead of a "one-size-fits-all" approach for the implementation of eHealth self-management interventions, it is essential to map and thoroughly understand the local context-specific factors to facilitate the implementation. Factors reported to influence the implementation of chronic kidney disease eHealth self-management interventions included information barriers (i.e. quality and consistency of the disease-related information obtained via eHealth), perceived trustworthiness and safety of eHealth sources, clinical compatibility and complexity of eHealth, time constraints and eHealth literacy. The stakeholder involvement via co-creation processes is a prerequisite for successful development and implementation of eHealth, and design should be mindful of vulnerable groups and eHealth illiteracy. Future research needs to increase eHealth literacy and credibility of eHealth (information resource), ensure eHealth to be easy to use and well-integrated into health care professionals' workflows.

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(*continued*)

What was already known on the topic

Authors' contributions

HS conceptualized and designed the study, interview procedures, drafted the initial manuscript, and conducted the analysis. RK and PB participated in the in the concept and design. WW and XS assisted in the focus group sessions, interpretation of data, revising of the manuscript. ZL and EB participated in the in the concept and design, interpretation of data, revising of the manuscript. NC participated in the concept and design, and revising of the manuscript. All authors read and approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

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