

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

Barriers and facilitators for reducing unnecessary vitamin testing in general practice: a qualitative analysis based on a grounded theory design

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-029760
Article Type:	Research
Date Submitted by the Author:	10-Feb-2019
Complete List of Authors:	Hofstede, Hetty; Department of General Practice, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands, van der Burg, Rosalie; Erasmus MC, University Medical Center Rotterdam, Department of General Practice Mulder, Bob; Wageningen University, Strategic Communication group, Wageningen, The Netherlands Bohnen, Arthur; Erasmus MC, University Medical Center Rotterdam, Department of General Practice Bindels, Patrick; Erasmus MC, University Medical Center Rotterdam, Department of General Practice de Wit, Niek; University Medical Center Utrecht, Julius Center for Primary Care de Schepper, E; Erasmus MC, University Medical Center Rotterdam, Department of General Practice van Vugt, Saskia; Department of General Practice, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands
Keywords:	Vitamin D [Mesh], Diagnostic tests [Mesh], General practice [Mesh], Qualitative Research [Mesh], Vitamin B 12 [Mesh]

SCHOLARONE™
Manuscripts

Barriers and facilitators for reducing unnecessary vitamin testing in general practice: a qualitative analysis based on a grounded theory design

H. Hofstede¹, H.A.M. van der Burg², B. Mulder³, A.M. Bohnen², P.J.E. Bindels², N.J. de Wit¹, E.I.T. de Schepper², S.F. van Vugt¹

1. Department of General Practice, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands

2. Department of General Practice, Erasmus MC, University Medical Center Rotterdam, The Netherlands

3. Wageningen University, Strategic Communication group, Wageningen, The Netherlands

Word count: 4453

Funding statement

The study was funded by the Citrien Fund, a national programme of the Dutch government initiated in 2015 (i.e. "Do or don't" programme) to reduce lower-value services, grant number: 8392010023. The funding source was not involved in the design, conduct, analysis, and interpretation of the data, nor in the writing and the decision to submit the paper.

Conflict of interest

All authors have no conflict of interest to report.

Author Contributions

HH, HB, BM, AB, ES, PB, NW, ES, and SV conceived the study idea and designed the study. HH, HB, BM, AB, ES, PB, NW, ES, and SV helped to develop the protocol and coordinated the collection of all data. HH and HB interpreted the data and performed the analyses, with help from BM, AB, ES, PB, NW, ES, and SV. HH wrote a first draft of the manuscript, and all mentioned co-authors critically revised the manuscript.

All authors had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing

Technical appendix and statistical code available from the corresponding author at S.F.vanVugt@umcutrecht.nl

1 **Abstract**

2 **Objective**

3
4 There has been an increase in testing of vitamins in patients in general practice, often based on
5 irrational indications or for non-specific symptoms, causing increasing healthcare expenditures and
6 medicalisation of patients. So far, there is little evidence of effective strategies to reduce this over-
7 testing in general practice. Therefore, the aim of this qualitative study was to explore the barriers and
8 facilitators for reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered.

9 **Design and setting**

10 This qualitative study, based on a grounded theory design, used semi-structured interviews among
11 general practitioners (GPs) and patients from two primary care networks (147 GPs; 195,000 patients).
12 These networks participated in the REVERT study (REducing Vitamin tEsting in pRIMARY care
13 practice), an RCT evaluating intervention strategies to reduce test ordering in primary care in the
14 Netherlands.

15 **Participants**

16
17 Twenty-one GPs, with a maximum of 1 GP per practice that took part in the REVERT study, and 22
18 patients (who were invited by their GP during vitamin-related consultations) were recruited, from which
19 20 GPs and 19 patients agreed to participate in this study.

20 **Results**

21
22 The most important factor hampering vitamin-test reduction programmes is the mismatch between
23 patients and medical professionals regarding the presumed appropriate indications for testing for
24 vitamin D and B12. In contrast, the most important facilitator for vitamin-test reduction may be
25 updating GPs' knowledge about test indications and their awareness of their own testing-behaviour.

26 **Conclusions**

27
28 To achieve a sustainable reduction in vitamin testing, guidelines with clear and uniform
29 recommendations on evidence-based indications for vitamin testing, combined with regular (individual)
30 feedback on test-ordering behaviour, are needed. Moreover, the general public need access to clear
31 and reliable information on vitamin testing. Further research is required to measure the effect of these
32 strategies on the number of vitamin test requests.

33
34
35 **Keywords:** Qualitative Research [Mesh], General practice [Mesh], Diagnostic tests [Mesh], Vitamin D
36 [Mesh], Vitamin B 12 [Mesh].

37
38 **Trial registration number:** This study was deemed by the University Medical Center Utrecht ethics
39 committee not to be subject to full assessment (protocol number WAG/mb/16/039555).

Strengths and limitations of this study

- This is the first study using semi-structured interviews to explore the barriers and facilitators for reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered.
- A qualitative approach with the use of open-coding allows all different aspects behind the complexity of reducing vitamin testing to be addressed.
- Potential bias due to selection of GPs affiliated to a research network and selection of patients by their GPs.

Introduction

The number of vitamin tests ordered in general practice has increased substantially in developed countries in recent years.¹ For example, the regional number of test requests for vitamin B12 in Utrecht, the Netherlands, increased almost sixfold between 2004 and 2014.² Vitamin D was the fifth most common laboratory test ordered for Medicare patients in the US in 2016, at a total cost of US\$350 million.³

Most indications for these tests are probably not evidence based, as a causal relationship with vitamin deficiencies for most health conditions is not present.^{4, 5} This over-testing could result in over-diagnosis and overtreatment with vitamin supplements, further increasing medicalisation, increasing healthcare costs, and irrational health perceptions.^{1, 5-7, 8} For example, previous research concluded that, although vitamin testing may potentially be useful in some high-risk groups, over-testing and overtreatment of vitamin D by general practitioners (GPs) resulted in professional and societal medicalisation of vitamin D.⁹ To counter this inappropriate medicalisation, a long-term strategy to reduce over-testing and over-supplementation is needed.^{9, 10}

Understanding barriers to, and facilitators for, reducing over-testing is essential to develop a long-term strategy to tackle this problem.¹⁰ For instance, Moynihan et al suggested that 'commercial and professional vested interests' and 'cultural beliefs that more is better' are facilitators of diagnostic testing that can lead to overdiagnosis.⁸ Furthermore, a qualitative study examining GPs' hidden motives in diagnostic decision making concluded that patients' reassurance was a strong motivation for GPs to perform or order diagnostic tests.¹¹ Next to GP related factors, many patient related factors may influence clinical decision.¹²

So far, no detailed information is available on the barriers and facilitators for rationalisation of vitamin test ordering in general practice. Therefore, we performed a qualitative assessment using semi-structured interviews among both GPs and patients to explore the barriers and facilitators for reducing the number of unnecessary vitamin D and B12 laboratory tests ordered.

1 Method

3 Design and setting

4 SRQR reporting guidelines were used for this qualitative study.¹³ This qualitative study, based on a
5 grounded theory design,¹⁴ used semi-structured interviews among GPs and patients from two primary
6 care networks in the Netherlands that participated in the REVERT study (REducing Vitamin tEsting in
7 pRimary care pracTice). The REVERT study was an RCT assessing the effectiveness of a GP
8 intervention programme including education, monitoring, and feedback on numbers in relation to
9 ordering vitamin D and B12 tests. Four times a year, GPs received feedback on the number of tests
10 they ordered. After randomisation, half of all participating practices also received patient information
11 on vitamin testing.¹⁵ In total, 22 general practices (117 GPs with 134,000 patients) in the Utrecht
12 region and 4 health centres (41 GPs and 61,000 patients) in the Rotterdam region participated in the
13 REVERT study.

15 Recruitment of participants

16 At the end of the one-year intervention period, a subset of GPs was invited for an interview. To secure
17 an adequate case mix regarding practice type and socioeconomic status of the practice area, only 1
18 general practitioner per REVERT practice was invited for an interview. Half of all invited GPs were
19 working in a practice that had received patient information on vitamin testing. The GPs were recruited
20 by mail and telephone.

21 Patients were recruited through the participating GPs; GPs were asked to invite patients during
22 consultations in which vitamin testing was a topic of conversation. When patients consented to be
23 interviewed on this topic, GPs provided the patients' name and telephone number to the researchers,
24 who contacted the patients.

27 Data collection

28 The interviews were performed during the last quartile of the intervention period of the REVERT study.
29 All interviews were performed by two interviewers (HH, RB). The interviewers were two master's
30 medical students with a background in medical research and/or qualitative research. The GP
31 interviews were conducted face-to-face in the GPs' office, and the patient interviews were conducted
32 by telephone. The interviews were semi-structured, and the content was developed collaboratively in a
33 multidisciplinary team of researchers, GPs, and a psychologist (BM) using previous research about
34 analysing de-implementation projects.¹⁶ The interviews lasted approximately 30 minutes and 15
35 minutes for GPs and patients, respectively, and consisted of four broad topic sections covering
36 barriers and facilitators for reducing the number of (unnecessary) vitamin D and B12 laboratory tests
37 ordered. The four topics were: 1) perceptions of, and reasons for, vitamin D and B12 testing; 2)
38 cognitive, motivational, and social factors potentially influencing the number of vitamin tests ordered;¹⁶
39 3) evaluation of the study intervention (e-module, education, and feedback); 4) ideas regarding a
40 successful strategy for a durable reduction in vitamin test ordering. Baseline characteristics of GPs

1 (sex, age, years working as GP, intervention group (de-implementation strategy 1 or 2), and patients
2 (sex, age, and education level) were ascertained at the end of the interview. Data on number of
3 patients per practice were retrieved by emailing the practices. In addition, data on socioeconomic
4 status (SES) were retrieved from the Social and Cultural Planning Office (SCP) in the Netherlands and
5 linked to our data through the four digits of the postal codes of the practice area. SCP calculates
6 socioeconomic status scores based on information concerning education, income, and position in the
7 labour market.¹⁷ We expected interviews with 20 GPs and 20 patients to be sufficient for item
8 saturation.¹⁸ During data collection, interim meetings were held with the interviewers (HH, RB) and
9 psychologist (BM) to discuss data and monitor progress towards saturation.

11 **Data analysis**

12 The interviews were recorded on audiotape and transcribed verbatim. Next, these data were coded
13 combining a deductive (i.e. Groll and Wensing's framework)¹⁶ and an inductive (i.e. data-driven)
14 approach, using QSR NVivo (version 11).¹⁹ All interviews were coded independently by two
15 researchers (HH and RB). The emerging themes were continuously compared with interview
16 transcripts. After coding about 14 interviews for both the GP and the patient group, no new codes were
17 added, indicating data saturation. The assigned codes and themes were discussed by the coding
18 researchers until consensus was achieved. Three researchers (RB, HH, and BM) further discussed
19 the themes and categorised them into interrelated topics.

22 **Results**

24 **Participants**

25 In total, 21 GPs from different practices were invited to participate. One GP declined, so in total 20
26 GPs agreed to participate in this study (5 GPs in Rotterdam and 15 GPs in Utrecht). The GPs'
27 characteristics are summarised in Table 1. Of the 22 patients who consented to participate in the
28 study, 3 could not be reached by telephone by the researchers. The characteristics of the final 19
29 patients interviewed are also summarised in Table 1.

31 **GPs' reasons for testing**

32 Two categories of reasons for testing could be distinguished: (1) medical reasons and (2) non-medical
33 reasons. These reasons for testing were influenced by (3) participation in the REVERT study.

35 **Medical reasons**

36 Patients considered to be at high-risk of vitamin-D deficiency (e.g. a dark skin) was most often
37 mentioned as a medical reason. Medical reasons for testing vitamin B12 levels were a low
38 haemoglobin level, neuropathic symptoms, and a potentially insufficient diet. GPs reported testing
39 vitamin D levels for non-specific symptoms (e.g. fatigue or myalgia) only in a minority of patients, or if
40 patients insisted on having their vitamin levels tested.

1 **Non-medical reasons**

2 Maintaining a good relationship with the patient, avoiding conflict, and creating goodwill for follow-up
3 consultations were mentioned both for vitamin D and B12 testing. These non-medical reasons were
4 important arguments to order the test, if patients persisted in their request to have their vitamin B12 or
5 D levels tested, despite adequate explanation by the GP.

6
7 *(GP1, woman, 31 years) 'Creating goodwill for follow-up consultations'*

8 *"You can't refuse every request, because that will not improve your relationship with the patient. You
9 will create goodwill, when you agree with some requests from the patients. As a consequence, they
10 will trust you more and they will agree with your advices in follow-up consultations, instead of refusing
11 them."*

12 **Influence of participation in REVERT study**

13 Most of the GPs mentioned that they reduced their vitamin D and B12 test ordering as a result of
14 participation in the REVERT study. They reported investing more time during the consultation in
15 explaining vitamin test indications and discussing reasons for not testing, after having followed the
16 education on vitamin testing.

17
18
19 About half of the GPs advised their patients to supplement vitamin D instead of having their vitamin D
20 level tested. A few GPs reported that they did not change much in their testing behaviour. They
21 indicated that, before participation in REVERT, they rarely tested vitamin levels.

22
23 *(GP11, man, 43 years) 'Advice to supplement vitamin D instead of testing'*

24 *"Now I tell patients that they could start with supplements if they think that there is an association
25 between their symptoms and a vitamin deficiency. Just start with supplements."*

26
27 *(GP7, woman, 65 years) 'Spending more time explaining'*

28 *"I give patients more information and explanation at this moment. I always tested vitamin D and B12
29 levels in patients complaining of fatigue before I received education. I don't do that anymore."*

30 **GPs' motivational factors**

31 Regarding the motivation to reduce unnecessary vitamin tests, three aspects could be identified: (1)
32 ideas and attitudes towards the usefulness of reducing vitamin tests, (2) attitudes towards the effort to
33 change testing behaviour, and (3) influence of intervention on motivation to change testing behaviour.

34 **Ideas and attitudes towards the usefulness of reducing vitamin tests**

35
36 Most of the GPs considered reduction of unnecessary vitamin testing as beneficial. These GPs
37 believed that they improved healthcare quality and cost efficiency by reducing unnecessary vitamin
38 tests, through preventing medicalisation of patients and/or reducing healthcare costs.

1 **Attitudes towards the effort to change behaviour**

2 Some GPs were not motivated to change their testing behaviour because they expected the resulting
3 reduction in healthcare costs to be disappointing. Another aspect of some GPs' negative attitude
4 towards reducing vitamin testing was their observation that symptoms in deficient patients were
5 resolved after they started vitamin D supplementation. One GP mentioned vitamin testing as being
6 helpful by using a 'proven low vitamin level' as 'placebo tool', being a substrate or explanation for their
7 symptoms.

9 **Influence of intervention on motivation to change testing behaviour**

10 GPs mentioned that feedback of their testing behaviour in the REVERT project helped them to stay
11 motivated to reduce unnecessary vitamin testing. For a sustainable strategy to reduce test ordering,
12 GPs suggested retaining this feedback on testing behaviour. Individual feedback instead of feedback
13 on the practice's performance might be more effective because it could create more insight into GPs'
14 personal test-ordering behaviour.

16 *(GP10, woman, 48 years) 'Preventing medicalisation'*

17 *"I think that if you continue with over-testing vitamin levels, you are giving patients the idea that vitamin*
18 *testing is very useful. When you stop over-testing vitamin levels, you will stimulate patients to reflect*
19 *on their total well-being instead of only requesting laboratory testing."*

21 *(GP13, man, 57 years) 'Awareness of testing behaviour'*

22 *"When you request laboratory tests, you have no idea about the number of requests you make. It*
23 *appears to be a lot more than you think. I didn't expect that."*

25 *(GP3, man, 34 years) 'Proven low vitamin level as placebo tool'*

26 *"It is a kind of tool which I can use and I don't want to lose that tool. I sometime use it as placebo. I'd*
27 *like to use this tool, because I think that I can help patients by saying that their symptoms might be*
28 *due to a low vitamin level and that the symptoms might disappear when they start with supplements. I*
29 *believe that, when using this placebo tool, I contribute to preventing patients from visiting other*
30 *specialists with their vague symptoms."*

32 **GPs' cognitive factors**

33 GPs' mentioned cognitive barriers and facilitators for reducing the number of vitamin tests. These can
34 be summarised in two categories: (1) influence of the REVERT intervention on GPs' knowledge and
35 (2) conflicting medical information.

37 **Influence of intervention on GPs' knowledge**

38 Up-to-date knowledge about the usefulness of vitamin tests, offered through the (online) education in
39 the REVERT study, was the most important facilitator for reducing vitamin testing according to the
40 GPs. GPs mentioned that, apart from the up-to-date knowledge, the concrete patient examples and

1 the background information about guideline-based indications for vitamin testing and treatment
2 discussed in the (online) education in the REVERT study also contributed to changing testing
3 behaviour regarding vitamin D and B12, because it was helpful in giving explanations to patients about
4 the usefulness of vitamin testing.

5
6 Lack of repetition of the information was mentioned as the most important cognitive barrier to
7 remembering, with the risk of falling back into old patterns of test ordering. Four GPs mentioned that it
8 was difficult to remember all the information received during the single moment of (online) education.
9 Nine GPs mentioned that it was easier to remember all the information if they had received other
10 education about this subject in the past or frequently discussed the topic in meetings with colleagues.

11 **Conflicting medical information**

12 Conflicting results and recommendations from other information sources were mentioned as the most
13 important barrier to reducing the number of vitamin tests requested by GPs. About half of the GPs
14 mentioned these conflicting results in the literature about the association between symptoms and
15 vitamin levels as a problem in building up their argumentation during the patient consultation. They
16 also mentioned that global recommendations, sometimes differ from national guideline
17 recommendations. These inter-country differences were mentioned as a reason for discussion with
18 patients. Some GPs therefore thought it difficult to resist vitamin test requests from patients, especially
19 when patients' "knowledge" seemed to be better than their own knowledge on this topic.

20
21
22 *(GP5, woman, 37 years) 'GP does not feel confident enough about knowledge'*

23 *"It is still very difficult to translate the information that you received from (online) education to an*
24 *explanation for a very demanding patient in 10 minutes. Especially when the patient has searched for*
25 *a lot of different articles that emphasise the importance of vitamin testing."*

26
27 As part of a sustainable strategy to reduce vitamin testing in general practice, GPs mentioned the
28 need for an overview of up-to-date knowledge about vitamin testing in a national guideline or protocol.
29 GPs thought that such a protocol would make it easier for health professionals to quickly search for
30 answers when unable to recall the information from previous (online) education.

31
32 *(GP4, woman, 38 years) 'Need for a protocol'*

33 *"So, I needed some kind of protocol that included the 10 most important things that I had learnt during*
34 *the online education. I noticed that I had difficulty recalling information from previous sessions and*
35 *therefore returned."*

36 **Social factors affecting GPs' testing behaviour**

37 GPs reported the following social factors affecting their testing-behaviour: (1) interaction with patients,
38 (2) attitudes of other health professionals, and (3) influence of media and society.

1 **Interaction with patients**

2 GPs indicated that good communication skills are needed to provide explanations and to convince
3 patients that vitamin tests are not always necessary. GPs also mentioned that a low education level
4 and language barriers made it more difficult to communicate and that they regarded these as barriers
5 to providing a good explanation to patients on the limited usefulness of vitamin testing.
6

7 GPs mentioned that it was easier to convince patients with whom they had a long relationship
8 compared to patients who were relatively new in their general practice. One GP mentioned using her
9 seniority, due to her age, making it easier to convince patients to agree with non-testing.
10

11 **Attitudes of other health professionals**

12 Six GPs mentioned that their partner GPs in the practice were less motivated to reduce unnecessary
13 vitamin tests or had different opinions about vitamin testing than themselves. Also, the presence of
14 locum doctors in the practice was mentioned as a barrier to reducing the number of vitamin tests
15 requested, because locums were found to request vitamin tests more often. In some practices,
16 assistants were able to request vitamin levels on their own initiative, limiting the reduction in vitamin
17 testing. On the other hand, four GPs reported that all the GPs in their practice had the same thoughts
18 and restrictive methods regarding vitamin testing. Furthermore, it was considered helpful if other
19 health professionals, e.g. GPs' assistants, had up-to-date knowledge about vitamin testing through
20 education in order to provide patients with the same message on the limited usefulness of vitamin
21 testing.
22

23 *(GP19, man, 35 years) 'Up-to-date knowledge among GPs' assistants*

24 *"It is important that the assistants have the same knowledge as the GPs, because they are asked the*
25 *most questions about vitamin testing."*
26

27 **Influence of media and society**

28 Another reported factor that made it difficult to reduce vitamin tests is the information spread about the
29 suggested importance of unrestricted vitamin D and B12 tests by other healthcare professionals, the
30 social media, or other patients. In line with this, GPs suggested that more support from colleagues,
31 media, and society should be part of a sustainable strategy to reduce unnecessary vitamin tests. GPs
32 specifically mentioned the need for reliable information resources for patients.
33

34 **Patients' motivational factors**

35 Two components of patients' motivation to change behaviour could be distinguished: (1) attitudes
36 towards GPs and (2) attitudes towards vitamin testing.
37

38 **Attitudes towards GPs**

39 About half of the patients mentioned that they had a negative attitude on this subject towards their GP.
40 These patients were convinced that their GP did not have enough knowledge about vitamins (tests);
41

1
2
3 1 this resulted in distrust and dissatisfaction with the information provided and the decisions made by
4 2 their GP regarding vitamin testing.
5
6 3

7 4 *(P12, woman, 40 years) 'GP does not have enough knowledge'*

8
9 5 *"I decided to look up all the information I wanted to know, because my GP couldn't tell me much about*
10 6 *it, that was a pity. I think that I do know more about vitamin testing than my GP knows."*
11
12 7

13 8 **Attitudes towards vitamin testing**

14
15 9 Most of the patients also had a negative attitude towards a policy of 'not testing' and even suggested
16 10 that it would be better if GPs increased vitamin testing and paid more attention to vitamin deficiencies.
17 11 In line with a negative attitude towards 'not testing', about 50% of the patients reported not seeing any
18 12 alternative for vitamin blood tests. Moreover, they stated their dissatisfaction with GPs who were
19 13 unwilling to test their vitamin levels. Two patients mentioned that they would keep asking their GP for
20 14 vitamin tests until their request was met.
21
22 15

23
24
25 16 *(P5, woman, 53 years) 'Keep asking the GP for vitamin testing'*

26 17 *"The GP always disagrees with my requests for vitamin testing, saying: 'I don't think that vitamin*
27 18 *deficiency is the problem'. I have to be very demanding and in the end I get what I want."*
28
29 19

30 20 Some patients mentioned that they would accept a satisfactory explanation from their GP about the
31 21 reasons for not testing if the GP disagreed with their vitamin test request. Two patients suggested that
32 22 health professionals with a background in alternative medicine could be consulted as an alternative for
33 23 having vitamin levels in their blood tested when the GP disagreed with their request.
34
35 24

36 37 38 25 **Patients' cognitive factors**

39 26 Two components of cognition and knowledge about vitamin (testing) can be identified in patients: (1)
40 27 thoughts and attitudes regarding information sources and (2) patients' reasons for wanting to be
41 28 tested.
42
43 29

44 45 30 **Thoughts and attitudes regarding information sources**

46 31 Most of the patients used the internet to search for information about vitamins. Five patients had read
47 32 information about vitamins in books and magazines. Psychological symptoms, myalgia, and fatigue
48 33 were the most frequently mentioned symptoms associated with vitamin D and B12 deficiencies.
49 34 Patients mentioned that the information that they found on the association between vitamin
50 35 deficiencies and symptoms gave them an explanation for their symptoms.
51
52 36

53
54
55 37 *(P17, woman 31 years) 'Online information sources'*

56 38 *"I decided to look online for more information and I recognised a lot of my symptoms in the stories that*
57 39 *I read on the internet."*
58
59 40

1
2
3 1 Patients thought it confusing that there are differences between reference levels and advices between
4 2 countries and study results. They mentioned that these differences made it more difficult to believe
5 3 that their GP's reference levels were correct.
6 4
7 5

6 5 ***Patients' reasons for wanting to be tested***

6 6 Patients' main reason for asking their GP to have their vitamin levels tested was fatigue. Other
7 7 reasons mentioned were depressive symptoms, weight loss, and myalgia. A vegetarian or vegan diet
8 8 was also mentioned as a reason for having a vitamin B12 test. Some patients mentioned that a history
9 9 of vitamin deficiency strengthened their request to have their vitamin D and/or B12 levels tested.
10 10
11 11

12 12 **Discussion**

14 14 **Summary of key findings**

15 15 In this qualitative analysis, we found a wide spectrum of patient- and GP-related perceptions and
16 16 attitudes that affect vitamin test ordering in clinical practice (summarised in Figure 1). The most
17 17 important factors hampering vitamin test reduction programmes are the mismatch between patients
18 18 and medical professionals regarding the presumed indications for testing for vitamin D and B12,
19 19 differences in motivation, and the GPs' tendency to avoid conflict. The most important facilitator for
20 20 vitamin test reduction programmes is updating GPs' knowledge about test indications in combination
21 21 with improving their awareness of their individual test behaviour.
22 22
23 23

23 23 *Reasons for testing differed between patients and GPs.*

24 24 For patients, the most important reasons to ask for vitamin testing were (non-specific) medical
25 25 symptoms based on information found on the internet and confirmed by other media, contacts, and
26 26 sometimes other healthcare professionals. GPs, however, mentioned being aware of the lack of
27 27 indication for vitamin testing when patients presented with non-specific medical symptoms.
28 28
29 29

29 29 GPs used information from the (online) project education to rebut patients' ideas and explain about the
30 30 limited usefulness of vitamin testing. Conflicting results and recommendations between different
31 31 information sources result in confusion about indications and the usefulness of vitamin testing among
32 32 both GPs and patients, creating discussion between GP and patients. A difference between patients
33 33 and GPs in their motivation to change testing behaviour was also identified. Whereas most GPs were
34 34 very motivated to reduce vitamin testing, most patients suggested that it would be better if GPs tested
35 35 more frequently for vitamin deficiencies in general practice.
36 36
37 37

37 37 Another barrier to reducing the number of vitamin tests was GPs' tendency to avoid conflict and satisfy
38 38 patients in order to foster good relationships with patients. In line with this, good communication skills
39 39 facilitated GPs in discussing and explaining the limited usefulness of vitamin testing to patients.
40 40

1
2
3 1 Other facilitators for reducing the number of vitamin tests according to GPs were consensus between
4 2 healthcare professionals and ongoing feedback on testing behaviour, but almost all GPs mentioned
5 3 up-to-date knowledge about the usefulness of vitamin testing through education as the most important
6 4 facilitator for reducing vitamin tests.
7
8
9

10 6 Following from this, to enable GPs to recall information, a reliable overview of the evidence and
11 7 recommendations regarding vitamin testing is warranted. GPs mentioned that this knowledge should
12 8 also be available to other healthcare professionals and patients in order to create unanimity about the
13 9 usefulness of vitamin tests. GPs also suggested getting regular individual feedback about their testing
14 10 behaviour to keep them motivated to test only when necessary and to have a tool to remind them to
15 11 change their testing behaviour.
16
17
18
19

20 13 **Results in context**

21
22 14 Patients and GPs having conflicting information was one of the main barriers to reducing unnecessary
23 15 vitamin testing. In line with our results, previous research has highlighted that not only health
24 16 professionals, but also the media, are key information providers on this topic for patients.²⁰ A media
25 17 content analysis showed that news articles linked vitamin D to a wide range of health conditions
26 18 without conclusive scientific evidence.²¹ As reflected by our study as well as previous research, this
27 19 has resulted in confusion regarding the usefulness of vitamin testing, among both patients and GPs.⁹
28 20 ²² Moreover, GPs' information sources also present conflicting results, reinforcing this confusion. To
29 21 counter this, previous research highlighted the need for clear information that reflects the actual state
30 22 of knowledge and for ongoing research for both healthcare professionals and patients.^{9, 10, 20} Similarly,
31 23 GPs in this study mentioned that clear guidelines for patients and GPs regarding vitamin testing would
32 24 help them in discussions with their patients.
33
34
35
36
37
38

39 26 Feedback on testing behaviour was found to be another important facilitator for reducing the number
40 27 of unnecessary vitamin tests. This is in line with an RCT that showed that feedback of requesting rates
41 28 was an effective strategy for reducing laboratory testing in primary care.²³ The results of a systematic
42 29 review suggest that feedback may be more effective when it is provided more than once and when it
43 30 includes both measurable targets and an action plan.²⁴ These suggestions could be useful for
44 31 implementing feedback on testing behaviour in the future. GPs suggested that feedback on individual
45 32 GP behaviour might be more effective than feedback on practice level. Such individual feedback might
46 33 contribute to the measurability of targets and a personalised action plan.
47
48
49
50
51

52 35 **Strengths and limitations**

53 36 This is the first study to use semi-structured interviews to explore the barriers and facilitators for
54 37 reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered. The qualitative
55 38 approach and the use of open-coding based on a broad theoretical framework allowed us to highlight
56 39 all the different aspects behind the complexity of reducing vitamin testing. The validity and reliability of
57
58
59
60

1
2
3 1 this study were strengthened by including patients from a broad range of backgrounds, as well as GPs
4 2 from 20 different practices.
5
6 3

7 4 Still, a few limitations need to be addressed. First, participating GPs were affiliated to a research
8 5 network and therefore might not have been representative of all GPs in the Netherlands. Next, patients
9 6 were invited for the interviews by their GPs; this creates a potential bias arising from the selection of,
10 7 for example, more outspoken patients. However, patient characteristics (Table 1) show large variation
11 8 in age, sex, and educational level, making inclusion of different patient perspectives likely. Finally,
12 9 even though the same interview guide was used, the interviews in this study were performed by two
13 10 different researchers, who may have had differences in their interviewing style that may have
14 11 influenced participants' responses.
15
16
17
18
19
20

21 13 **Recommendations**

22 14 From a GP's perspective, a sustainable reduction in vitamin test requests in primary care requires the
23 15 following steps: (1) updating GPs' knowledge through (online) education, (2) guidelines with clear and
24 16 uniform recommendations on prevailing indications for vitamin testing and supplementation for all
25 17 healthcare professionals, and (3) regular (individual) feedback on GPs' test behaviour.
26
27
28

29 19 From a societal perspective, access to clear and reliable information on vitamin testing for the
30 20 population is needed, from trustful sources. In addition, the spread of non-evidence-based information
31 21 through lay media should be challenged. Further research is required to measure the effect of these
32 22 strategies on reducing vitamin testing.
33
34
35

36 24 **Conclusion**

37 25 In conclusion, conflicting information about the usefulness of vitamin testing, differences in motivation
38 26 between patients and GPs, as well as GPs' tendency to avoid conflict and to satisfy patients are
39 27 important barriers to reducing the number of vitamin tests. Nevertheless, updating GPs' knowledge,
40 28 feedback on GPs' testing behaviour, and guidelines with clear recommendations for all healthcare
41 29 professionals (including patient information) on prevailing indications for vitamin testing and
42 30 supplementation could facilitate a sustainable reduction in vitamin testing in primary care.
43
44
45
46
47
48
49

50 33 **Acknowledgements**

51 34 We would like to thank the entire REVERT team for their diligence, expertise and enthusiasm. Finally,
52 35 we are indebted to all patients and GPs who consented to be interviewed, without whom this study
53 36 would not have been possible.
54
55
56
57
58
59
60

References

- 1 Sattar N, Welsh P, Panarelli M, et al. Increasing requests for vitamin D measurement: costly, confusing, and without credibility. *The Lancet* 2012;379:95–6.
- 2 Franken P, Geutjes P, van den Ouweland J, et al. Diagnose van vitamine-B12-tekort. *Huisarts en wetenschap* 2015;58:530–1.
- 3 Medicare Payments for Clinical Diagnostic Laboratory Tests in 2016: Year 3 of Baseline Data 2017. <https://oig.hhs.gov/oei/reports/oei-09-17-00140.asp>.
- 4 Bilinski K, Boyages S. Evidence of overtesting for vitamin D in Australia: an analysis of 4.5 years of Medicare Benefits Schedule (MBS) data. *BMJ Open* 2013;3:e002955. doi: 10.1136/bmjopen-2013-002955
- 5 LeFevre ML, LeFevre NM. Vitamin D Screening and Supplementation in Community-Dwelling Adults: Common Questions and Answers. *Am Fam Physician* 2018;97(4):254-60.
- 6 Bindels PJ. Vitamin D: what to do with it? *Ned Tijdschr Geneesk* 2015;159:A8837.
- 7 Langan RC, Goodbred AJ. Vitamin B 12 Deficiency: Recognition and Management. *Am Fam Physician* 2017;96:384–89.
- 8 Moynihan R, Doust J, Henry D. Preventing overdiagnosis: how to stop harming the healthy. *BMJ: British Medical Journal (Online)* 2012;344:e3502. doi: 10.1136/bmj.e3502.
- 9 Kotta S, Gadhvi D, Jakeways N, et al. "Test me and treat me"-attitudes to vitamin D deficiency and supplementation: a qualitative study. *BMJ Open* 2015;5: e007401. doi:10.1136/bmjopen-2014-007401
- 10 Gowda U, Smith BJ, Wluka AE, et al. Vitamin D testing patterns among general practitioners in a major Victorian primary health care service. *Aust N Z J Public Health* 2016;40:144–7.
- 11 Michiels-Corsten M, Donner-Banzhoff N. Beyond accuracy: hidden motives in diagnostic testing. *Fam Pract* 2018;35:222–7.
- 12 Haijaj FM, Salek MS, Basra MK, et al. Non-clinical influences on clinical decision-making: a major challenge to evidence-based practice. *J R Soc Med* 2010;103:178-87.
- 13 O'Brien BC, Harris IB, Beckman TJ, et al. Standards for reporting qualitative research: a synthesis of recommendations. *Acad Med* 2014;89:1245-51. doi:10.1097/ACM.0000000000000388.

- 1
2
3 14 Charmaz K. *Constructing grounded theory: A practical guide through qualitative analysis*. Sage
4 2006.
5
6
7 15 Bindels, Schepper, Wit, et al. Intervention to reduce vitamin testing in primary care: a RCT, article
8 submitted.
9
10
11 16 Grol R, Wensing M, Bosch M, et al. Theories on implementation of change in healthcare. *Improving*
12 *Patient Care: The Implementation of Change in Health Care, Second Edition* 2013:18–39.
13
14
15 17 Social and Cultural office [Sociaal en Cultureel Planbureau], Social economic factors
16 [Statusscores]. 2009.
17
18
19 18 Guest G, Bunce A, Johnson L. How many interviews are enough? An experiment with data
20 saturation and variability. *Field Methods* 2006;18:59–82.
21
22
23 19 Zamawe FC. The implication of using NVivo software in qualitative data analysis: Evidence-based
24 reflections. *Malawi Medical Journal* 2015;27:13–15.
25
26
27 20 Deschasaux M, Souberbielle J, Partula V, et al. What do people know and believe about vitamin
28 D?. *Nutrients* 2016;8:718.
29
30
31 21 Caulfield T, Clark MI, McCormack JP, et al. Representations of the health value of vitamin D
32 supplementation in newspapers: media content analysis. *BMJ Open* 2014;4: e006395. doi:10.1136/
33 bmjopen-2014-006395.
34
35
36
37 22 Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient
38 management of health and uncertainty. *Qual Health Res* 2014;24:375–86.
39
40
41 23 Thomas RE, Croal BL, Ramsay C, et al. Effect of enhanced feedback and brief educational
42 reminder messages on laboratory test requesting in primary care: a cluster randomised trial. *The*
43 *Lancet* 2006;367:1990–6.
44
45
46 24 Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and
47 healthcare outcomes. *Cochrane Database of Systematic Reviews* 2012. Issue 6. Art. No.: CD000259.
48 DOI: 10.1002/14651858.CD000259.pub3.
49
50
51
52
53
54
55
56
57
58
59
60

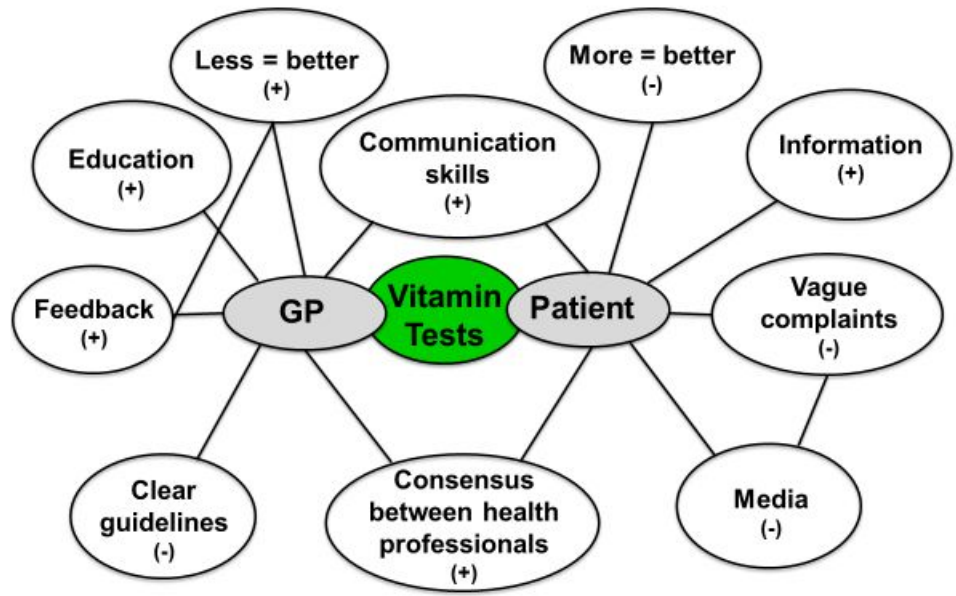
Table 1. Baseline characteristics of included general practitioners and patients

	GP (n=20) Mean \pm SD / n (%)		Patients (n=19) Mean \pm SD / n (%)
Sex (female, n (%))	14 (70.0)	Sex (female, n (%))	17 (89.5)
Age (years, mean \pm SD)	45.8 \pm 9.9	Age (years, mean \pm SD)	42.6 \pm 13.9
Practice experience as GP (years, mean \pm SD)	14.4 \pm 10.0	Educational level ² (high, n (%))	13 (68.4)
Number of patients in practice (mean \pm SD)	6807 \pm 3104	Requested for vitamin B12 (yes, n (%))	11 (57.9)
Socioeconomic status of patients in practice ¹	0.59 \pm 1.04	Requested for vitamin D (yes, n (%))	16 (84.2)
Intervention			
Online education (yes, n (%))	12 (60.0)		
Education vitamin testing (yes, n (%))	12 (60.0)		
Communication training (yes, n (%))	13 (65.0)		
Received feedback (yes, n (%))	16 (80.0)		
Patient information (yes, n (%))	11 (55.0)		

1 Socioeconomic status data were retrieved from the Social and Cultural Planning Office (SCP) and linked by four digital postal codes to our data. SCP calculates social economic status scores based on information regarding education, income and position in the labour market. A socioeconomic status score of 0 defines the mean socioeconomic status in the Netherlands. A score > 0 defines a socioeconomic status higher than the mean in the Netherlands. A score < 0 defines a socioeconomic status lower than the mean in the Netherlands.

2 A high educational level was defined as an academic bachelor degree or higher.

Fig. 1. Overview of key factors influencing the reduction in vitamin tests.



- = barrier to reducing vitamin tests
+ = facilitator for reducing vitamin tests

view only

Reporting checklist for qualitative study.

Based on the SRQR guidelines.

		Reporting Item	Page Number
	#1	Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g. ethnography, grounded theory) or data collection methods (e.g. interview, focus group) is recommended	1
	#2	Summary of the key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results and conclusions	2
Problem formulation	#3	Description and significance of the problem / phenomenon studied: review of relevant theory and empirical work; problem statement	3
Purpose or research question	#4	Purpose of the study and specific objectives or questions	3
Qualitative approach and research paradigm	#5	Qualitative approach (e.g. ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g. postpositivist, constructivist /	4

interpretivist) is also recommended; rationale. The rationale should briefly discuss the justification for choosing that theory, approach, method or technique rather than other options available; the assumptions and limitations implicit in those choices and how those choices influence study conclusions and transferability. As appropriate the rationale for several items might be discussed together.

<p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35</p>	<p>Researcher characteristics and reflexivity</p>	<p>#6</p>	<p>Researchers' characteristics that may influence the research, including personal attributes, qualifications / experience, relationship with participants, assumptions and / or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results and / or transferability</p>	<p>4</p>
<p>36 37 38</p>	<p>Context</p>	<p>#7</p>	<p>Setting / site and salient contextual factors; rationale</p>	<p>4</p>
<p>39 40 41 42 43 44 45 46 47 48</p>	<p>Sampling strategy</p>	<p>#8</p>	<p>How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g. sampling saturation); rationale</p>	<p>4</p>
<p>49 50 51 52 53 54 55 56 57 58 59 60</p>	<p>Ethical issues pertaining to human subjects</p>	<p>#9</p>	<p>Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues</p>	<p>2</p>

1	Data collection methods	#10	Types of data collected; details of data collection	4,5
2				
3			procedures including (as appropriate) start and stop	
4			dates of data collection and analysis, iterative process,	
5			triangulation of sources / methods, and modification of	
6			procedures in response to evolving study findings;	
7			rationale	
8				
9				
10				
11				
12				
13				
14				
15	Data collection	#11	Description of instruments (e.g. interview guides,	4,5
16				
17	instruments and		questionnaires) and devices (e.g. audio recorders) used	
18			for data collection; if / how the instruments(s) changed	
19	technologies		over the course of the study	
20				
21				
22				
23				
24				
25	Units of study	#12	Number and relevant characteristics of participants,	5
26				
27			documents, or events included in the study; level of	
28			participation (could be reported in results)	
29				
30				
31				
32				
33	Data processing	#13	Methods for processing data prior to and during	4,5
34				
35			analysis, including transcription, data entry, data	
36			management and security, verification of data integrity,	
37			data coding, and anonymisation / deidentification of	
38			excerpts	
39				
40				
41				
42				
43				
44				
45	Data analysis	#14	Process by which inferences, themes, etc. were	5
46				
47			identified and developed, including the researchers	
48			involved in data analysis; usually references a specific	
49			paradigm or approach; rationale	
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

1	Techniques to enhance	#15	Techniques to enhance trustworthiness and credibility	4,5
2				
3	trustworthiness		of data analysis (e.g. member checking, audit trail,	
4			triangulation); rationale	
5				
6				
7				
8	Syntheses and	#16	Main findings (e.g. interpretations, inferences, and	5-11
9			themes); might include development of a theory or	
10	interpretation		model, or integration with prior research or theory	
11				
12				
13				
14				
15				
16	Links to empirical data	#17	Evidence (e.g. quotes, field notes, text excerpts,	5-11
17			photographs) to substantiate analytic findings	
18				
19				
20				
21				
22	Intergration with prior	#18	Short summary of main findings; explanation of how	11-13
23			findings and conclusions connect to, support, elaborate	
24	work, implications,		on, or challenge conclusions of earlier scholarship;	
25			discussion of scope of application / generalizability;	
26	transferability and		identification of unique contributions(s) to scholarship in	
27			a discipline or field	
28	contribution(s) to the			
29	field			
30				
31				
32				
33				
34				
35				
36	Limitations	#19	Trustworthiness and limitations of findings	12-13
37				
38				
39	Conflicts of interest	#20	Potential sources of influence of perceived influence on	1
40			study conduct and conclusions; how these were	
41			managed	
42				
43				
44				
45				
46				
47	Funding	#21	Sources of funding and other support; role of funders in	1
48			data collection, interpretation and reporting	
49				
50				
51				

The SRQR checklist is distributed with permission of Wolters Kluwer © 2014 by the Association of American Medical Colleges. This checklist was completed on 02. February 2019 using

1 <https://www.goodreports.org/>, a tool made by the [EQUATOR Network](#) in collaboration with

2
3 [Penelope.ai](#)
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

BMJ Open

Reducing unnecessary vitamin testing in general practice: barriers and facilitators according to general practitioners and patients.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-029760.R1
Article Type:	Research
Date Submitted by the Author:	08-Jul-2019
Complete List of Authors:	Hofstede, Hetty; Department of General Practice, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands, van der Burg, Rosalie; Erasmus MC, University Medical Center Rotterdam, Department of General Practice Mulder, Bob; Wageningen University, Strategic Communication group, Wageningen, The Netherlands Bohnen, Arthur; Erasmus MC, University Medical Center Rotterdam, Department of General Practice Bindels, Patrick; Erasmus MC, University Medical Center Rotterdam, Department of General Practice de Wit, Niek; University Medical Center Utrecht, Julius Center for Primary Care de Schepper, E; Erasmus MC, University Medical Center Rotterdam, Department of General Practice van Vugt, Saskia; Department of General Practice, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Diagnostics, Patient-centred medicine, Communication
Keywords:	Vitamin D [Mesh], Diagnostic tests [Mesh], General practice [Mesh], Qualitative Research [Mesh], Vitamin B 12 [Mesh]

SCHOLARONE™
Manuscripts

1
2
3 1 Technical appendix and statistical code available from the corresponding author at
4 2 S.F.vanVugt@umcutrecht.nl
5
6
7 3

4 **Abstract**

5 6 **Objective**

7 There has been an increase in testing of vitamins in patients in general practice, often based on
8 irrational indications or for non-specific symptoms, causing increasing healthcare expenditures and
9 medicalisation of patients. So far, there is little evidence of effective strategies to reduce this over-
10 testing in general practice. Therefore, the aim of this qualitative study was to explore the barriers and
11 facilitators for reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered.
12

13 **Design and setting**

14 This qualitative study, based on a grounded theory design, used semi-structured interviews among
15 general practitioners (GPs) and patients from two primary care networks (147 GPs; 195,000 patients).
16 These networks participated in the REVERT study (REducing Vitamin tEsting in pRimary care
17 practice), an RCT evaluating intervention strategies to reduce test ordering in primary care in the
18 Netherlands.
19

20 **Participants**

21 Twenty-one GPs, with a maximum of 1 GP per practice that took part in the REVERT study, and 22
22 patients (who were invited by their GP during vitamin-related consultations) were recruited, from which
23 20 GPs and 19 patients agreed to participate in this study.
24

25 **Results**

26 The most important factor hampering vitamin-test reduction programmes is the mismatch between
27 patients and medical professionals regarding the presumed appropriate indications for testing for
28 vitamin D and B12. In contrast, the most important facilitator for vitamin-test reduction may be
29 updating GPs' knowledge about test indications and their awareness of their own testing-behaviour.
30

31 **Conclusions**

32 To achieve a sustainable reduction in vitamin testing, guidelines with clear and uniform
33 recommendations on evidence-based indications for vitamin testing, combined with regular (individual)
34 feedback on test-ordering behaviour, are needed. Moreover, the general public need access to clear
35 and reliable information on vitamin testing. Further research is required to measure the effect of these
36 strategies on the number of vitamin test requests.
37

1
2
3 1 **Keywords:** Qualitative Research [Mesh], General practice [Mesh], Diagnostic tests [Mesh], Vitamin D
4 2 [Mesh], Vitamin B 12 [Mesh].
5
6 3

7 4 **Trial registration number:** This study was deemed by the University Medical Center Utrecht ethics
8 5 committee not to be subject to full assessment (protocol number WAG/mb/16/039555).
9
10 6

11 7 **Strengths and limitations of this study**

- 12 8 • This is the first study using semi-structured interviews to explore the barriers and facilitators
13 9 for reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered.
- 14 10 • A qualitative approach with the use of open-coding allows all different aspects behind the
15 11 complexity of reducing vitamin testing to be addressed.
- 16 12 • Potential bias due to selection of GPs affiliated to a research network and selection of patients
17 13 by their GPs.
18
19
20
21
22
23
24
25
26
27
28
29
30
31

32 16 **Introduction**

33 18 The number of vitamin tests ordered in general practice has increased substantially in developed
34 19 countries in recent years.¹ For example, the regional number of test requests for vitamin B12 in
35 20 Utrecht, the Netherlands, increased almost sixfold between 2004 and 2014.² Vitamin D was the fifth
36 21 most common laboratory test ordered for Medicare patients in the US in 2016, at a total cost of
37 22 US\$350 million.³
38
39
40

41 24 Most indications for these tests are probably not evidence based, as a causal relationship with vitamin
42 25 deficiencies for most health conditions is not present.^{4, 5} This over-testing could result in over-
43 26 diagnosis and overtreatment with vitamin supplements, further increasing medicalisation, increasing
44 27 healthcare costs, and irrational health perceptions.^{1, 5-7, 8} For example, previous research concluded
45 28 that, although vitamin testing may potentially be useful in some high-risk groups, over-testing and
46 29 overtreatment of vitamin D by general practitioners (GPs) resulted in professional and societal
47 30 medicalisation of vitamin D.⁹ To counter this inappropriate medicalisation, a long-term strategy to
48 31 reduce over-testing and over-supplementation is needed.^{9, 10}
49
50
51
52
53

54 33 So far, there is little evidence of effective strategies to reduce this over-testing in general practice,
55 34 although clinical decision support rules seem promising.¹¹ Understanding barriers to, and facilitators
56 35 for, reducing over-testing is essential to develop a long-term strategy to tackle this problem.¹⁰ For
57 36 instance, Moynihan et al. suggested that 'commercial and professional vested interests' and 'cultural
58 37 beliefs that more is better' are facilitators of diagnostic testing that can lead to overdiagnosis.⁸
59
60

1
2
3 1 Furthermore, a qualitative study examining GPs' hidden motives in diagnostic decision making
4 2 concluded that patients' reassurance was a strong motivation for GPs to perform or order diagnostic
5 3 tests.¹² Next to GP related factors, many patient related factors may influence clinical decision.¹³
6 4

7
8
9 5 So far, theoretical perspectives as well as empirical studies on the barriers and facilitators of vitamin
10 6 test ordering in general practice are lacking. Therefore, we performed a qualitative assessment using
11 7 semi-structured interviews among both GPs and patients to explore the barriers and facilitators for
12 8 reducing the number of unnecessary ordered vitamin D and B12 laboratory tests.
13 9
14
15
16
17
18
19
20
21
22

23 11 **Method**

24 13 **Design and setting**

25 14 SRQR reporting guidelines were used for this qualitative study.¹⁴ This qualitative study used a
26 15 grounded theory design,¹⁵ because this design is explicitly suited for examining how meanings in
27 16 people's perceptions are related to their actions. Applied to our study, using grounded theory allowed
28 17 us to study how meanings attached to vitamin testing interrelate to choices and because this design is
29 18 explicitly suited for examining how meanings in people's perceptions are related to their actions.
30 19 Applied to our study, using grounded theory allowed us to study how meanings attached to vitamin
31 20 testing interrelate to choices and actions regarding vitamin testing, for both GPs and patients. The aim
32 21 is, ultimately, to develop new theoretical concepts, grounded in qualitative data, which represent
33 22 barriers and facilitators for vitamin testing, currently not reported in the literature. These new
34 23 theoretical concepts may be further developed and tested in future research.
35 24

36 25 Data were collected through semi-structured interviews among GPs and patients from two primary
37 26 care networks in the Netherlands that participated in the REVERT study (REducing Vitamin tESting in
38 27 pRimary care pracTice). The REVERT study was an RCT assessing the effectiveness of a GP
39 28 intervention programme including education, monitoring, and feedback on numbers in relation to
40 29 ordering vitamin D and B12 tests. Four times a year, GPs received feedback on the number of tests
41 30 they ordered. After randomisation, half of all participating practices also received patient information
42 31 on vitamin testing. In total, 22 general practices (117 GPs with 134,000 patients) in the Utrecht region
43 32 and 4 health centres (41 GPs and 61,000 patients) in the Rotterdam region participated in the
44 33 REVERT study (van Vugt SF, de Schepper EIT, van Delft S. et al. Reducing vitamin test ordering in
45 34 primary care: the effectiveness of a professional and patient oriented strategy).
46 35
47
48
49
50
51
52
53
54

55 36 **Recruitment of participants**

56 37 At the end of the one-year intervention period, we have invited all participating general practices for an
57 38 interview by telephone or face to face by one of the researchers. To secure an adequate case mix
58 39 regarding practice type and socioeconomic status of the practice area, only 1 general practitioner per
59 40 REVERT practice was invited for an interview.

1
2
3 1
4 2 Patients were recruited through the participating GPs; GPs were asked to invite patients during
5 3 consultations in which vitamin testing was a topic of conversation. The GPs asked them if they were
6 4 willing to be interviewed about vitamin testing. When patients consented to be interviewed on this
7 5 topic, GPs provided the patients' name and telephone number to the researchers, who contacted the
8 6 patients. We aimed to recruit a mixed sample in terms of age, gender, ethnicity and educational level,
9 7 because large variation as to demographic characteristics helps to recruit a sample with the widest
10 8 range of possible experiences, opinions and preferences. This is necessary for a full exploration of this
11 9 issue.
12 10

11 **Data collection**

12 The interviews were performed by two interviewers (HH, RB), during the last quartile of the
13 13 intervention period of the REVERT study. The interviewers were two master's medical students with a
14 14 background in medical research and/or qualitative research, supported by a multidisciplinary team of
15 15 researchers, GPs, and a psychologist specialized in communication research (BM). BM trained HH
16 16 and RB in how to apply guidelines for doing in-depth interviews.

17 The GP interviews were conducted face-to-face in the GPs' office, and the patient interviews
18 18 were conducted by telephone. Interviews lasted approximately 30 minutes and 15 minutes for GPs
19 19 and patients, respectively, and were semi-structured using a list that covered four broad topics of
20 20 barriers and facilitators for reducing the number of (unnecessary) vitamin D and B12 testing. The four
21 21 topics were based on the framework by Grol and Wensing¹⁶, namely: 1) perceptions of, and reasons
22 22 for, vitamin D and B12 testing; 2) cognitive, motivational, and social factors potentially influencing the
23 23 number of vitamin tests ordered;¹⁶ 3) evaluation of the study intervention (e-module, education, and
24 24 feedback); 4) ideas regarding a successful strategy for a durable reduction in vitamin test ordering.
25 25 Baseline characteristics of GPs (sex, age, years working as GP, intervention group (de-
26 26 implementation strategy 1 or 2), and patients (sex, age, and education level) were ascertained at the
27 27 end of the interview. Data on number of patients per practice were retrieved by emailing the practices.
28 28 In addition, data on socioeconomic status (SES) were retrieved from the Social and Cultural Planning
29 29 Office (SCP) in the Netherlands and linked to our data through the four digits of the postal codes of the
30 30 practice area. SCP calculates socioeconomic status scores based on information concerning
31 31 education, income, and position in the labour market.¹⁷ We expected interviews with 20 GPs and 20
32 32 patients to be sufficient for item saturation.¹⁸ During data collection, interim meetings were held with
33 33 the interviewers (HH, RB) and psychologist (BM) to discuss data and monitor progress towards
34 34 saturation.

35 Based on a previous study, we expected a minimum of approximately 12 interviews with GPs
36 36 and 12 interviews with patients to be sufficient for saturation,¹⁸ although numbers mentioned in the
37 37 literature vary, and thus cannot be taken as absolute indicators of saturation or any other criterium. To
38 38 guarantee at least 12 interviews per group, the aim was to organise about 20 interviews with GPs and
39 39 20 interviews with patients. Twenty-one GPs from different practices were invited to participate. One
40 40 GP declined, so in total 20 GPs agreed to participate in this study (5 GPs in Rotterdam and 15 GPs in

1 Utrecht). Of the 22 patients who consented to participate in the study, 3 could not be reached by
2 telephone by the researchers, resulting in 19 interviewed patients.

4 **Data analysis**

5 The interviews were recorded on audiotape and transcribed verbatim. Next, these data were coded
6 combining a deductive (i.e. Grof and Wensing's framework)¹⁶ and an inductive (i.e. data-driven)
7 approach, using QSR NVivo (version 11).¹⁹ All interviews were coded independently by two
8 researchers (HH and RB). The emerging themes were continuously compared with interview
9 transcripts. During data collection, interim meetings were held with the interviewers (HH, RB) and
10 communication researcher (BM) to discuss data collection and analysis, including emerging themes
11 and how these interrelated. The assigned codes and themes were discussed by the coding
12 researchers until consensus was achieved.

13 Data saturation was monitored and discussed as well. After coding 14 interviews for the GP
14 group and 14 interviews for the patient group, no new codes were added, which means that data
15 saturation was reached at that point.

17 **Patient and public involvement**

18 Patients and or public were not involved in the design, recruitment and conduct of the study.

21 **Results**

23 **Participants**

24 The characteristics of the 20 GPs and 19 patients who participated in the study are summarised in
25 Table 1.

Table 1. Baseline characteristics of included general practitioners and patients

	GP (n=20) Mean ± SD / n (%)		Patients (n=19) Mean ± SD / n (%)
Sex (female, n (%))	14 (70.0)	Sex (female, n (%))	17 (89.5)
Age (years, mean ± SD)	45.8 ± 9.9	Age (years, mean ± SD)	42.6 ± 13.9
Practice experience as GP (years, mean ± SD)	14.4 ± 10.0	Educational level ² (high, n (%))	13 (68.4)
Number of patients in practice (mean ± SD)	6807 ± 3104	Requested for vitamin B12 (yes, n (%))	11 (57.9)
Socioeconomic status of patients in practice ¹	0.59 ± 1.04	Requested for vitamin D (yes, n (%))	16 (84.2)
Intervention			
Online education (yes, n (%))	12 (60.0)		
Education vitamin testing (yes, n (%))	12 (60.0)		
Communication training (yes, n (%))	13 (65.0)		
Received feedback (yes, n (%))	16 (80.0)		
Patient information (yes, n (%))	11 (55.0)		

1 Socioeconomic status data were retrieved from the Social and Cultural Planning Office (SCP) and linked by four digital postal codes to our data. SCP calculates social economic status scores based on information regarding education, income and position in the labour market. A socioeconomic status score of 0 defines the mean socioeconomic status in the Netherlands. A score > 0 defines a socioeconomic status higher than the mean in the Netherlands. A score < 0 defines a socioeconomic status lower than the mean in the Netherlands.

2 A high educational level was defined as an academic bachelor degree or higher.

2 GPs' reasons for testing

3 Two categories of reasons for testing could be distinguished: (1) medical reasons and (2) non-medical
4 reasons. These reasons for testing were influenced by (3) participation in the REVERT study.

6 **Medical reasons**

7 Patients considered to be at high-risk of vitamin-D deficiency (e.g. a dark skin) was most often
8 mentioned as a medical reason. Medical reasons for testing vitamin B12 levels were a low
9 haemoglobin level, neuropathic symptoms, and a potentially insufficient diet. GPs reported testing
10 vitamin D levels for non-specific symptoms (e.g. fatigue or myalgia) only in a minority of patients, or if
11 patients insisted on having their vitamin levels tested.

12 **Non-medical reasons**

13 Maintaining a good relationship with the patient, avoiding conflict, and creating goodwill for follow-up
14 consultations were mentioned both for vitamin D and B12 testing. These non-medical reasons were
15 important arguments to order the test, if patients persisted in their request to have their vitamin B12 or
16 D levels tested, despite adequate explanation by the GP.

17
18 *(GP1, woman, 31 years) 'Creating goodwill for follow-up consultations'*

19 *"You can't refuse every request, because that will not improve your relationship with the patient. You
20 will create goodwill, when you agree with some requests from the patients. As a consequence, they
21 will trust you more and they will agree with your advices in follow-up consultations, instead of refusing
22 them."*

24 **Influence of participation in REVERT study**

25 Most of the GPs mentioned that they reduced their vitamin D and B12 test ordering as a result of
26 participation in the REVERT study. They reported investing more time during the consultation in
27 explaining vitamin test indications and discussing reasons for not testing, after having followed the
28 education on vitamin testing.

29
30 About half of the GPs advised their patients to supplement vitamin D instead of having their vitamin D
31 level tested. A few GPs reported that they did not change much in their testing behaviour. They
32 indicated that, before participation in REVERT, they rarely tested vitamin levels.

33
34 *(GP11, man, 43 years) 'Advice to supplement vitamin D instead of testing'*

35 *"Now I tell patients that they could start with supplements if they think that there is an association
36 between their symptoms and a vitamin deficiency. Just start with supplements."*

37
38 *(GP7, woman, 65 years) 'Spending more time explaining'*

39 *"I give patients more information and explanation at this moment. I always tested vitamin D and B12
40 levels in patients complaining of fatigue before I received education. I don't do that anymore."*

1
2
3 1
4
5 2**GPs' motivational factors**

6 3 Regarding the motivation to reduce unnecessary vitamin tests, three aspects could be identified: (1)
7 4 ideas and attitudes towards the usefulness of reducing vitamin tests, (2) attitudes towards the effort to
8 5 change testing behaviour, and (3) influence of intervention on motivation to change testing behaviour.
9 6

Ideas and attitudes towards the usefulness of reducing vitamin tests

10 7
11 8 Most of the GPs considered reduction of unnecessary vitamin testing as beneficial. These GPs
12 9 believed that they improved healthcare quality and cost efficiency by reducing unnecessary vitamin
13 10 tests, through preventing medicalisation of patients and/or reducing healthcare costs.
14 11

Attitudes towards the effort to change behaviour

15 12 Some GPs were not motivated to change their testing behaviour because they expected the resulting
16 13 reduction in healthcare costs to be disappointing. Another aspect of some GPs' negative attitude
17 14 towards reducing vitamin testing was their observation that symptoms in deficient patients were
18 15 resolved after they started vitamin D supplementation. One GP mentioned vitamin testing as being
19 16 helpful by using a 'proven low vitamin level' as 'placebo tool', being a substrate or explanation for their
20 17 symptoms.
21 18

Influence of intervention on motivation to change testing behaviour

22 19
23 20 GPs mentioned that feedback of their testing behaviour in the REVERT project helped them to stay
24 21 motivated to reduce unnecessary vitamin testing. For a sustainable strategy to reduce test ordering,
25 22 GPs suggested retaining this feedback on testing behaviour. Individual feedback instead of feedback
26 23 on the practice's performance might be more effective because it could create more insight into GPs'
27 24 personal test-ordering behaviour.
28 25
29 26

30 27 (GP10, woman, 48 years) 'Preventing medicalisation'

31 28 "I think that if you continue with over-testing vitamin levels, you are giving patients the idea that vitamin
32 29 testing is very useful. When you stop over-testing vitamin levels, you will stimulate patients to reflect
33 30 on their total well-being instead of only requesting laboratory testing."
34 31

35 32 (GP13, man, 57 years) 'Awareness of testing behaviour'

36 33 "When you request laboratory tests, you have no idea about the number of requests you make. It
37 34 appears to be a lot more than you think. I didn't expect that."
38 35

39 36 (GP3, man, 34 years) 'Proven low vitamin level as placebo tool'

40 37 "It is a kind of tool which I can use and I don't want to lose that tool. I sometime use it as placebo. I'd
41 38 like to use this tool, because I think that I can help patients by saying that their symptoms might be
42 39 due to a low vitamin level and that the symptoms might disappear when they start with supplements. I
43 40
44 41
45 42
46 43
47 44
48 45
49 46
50 47
51 48
52 49
53 50
54 51
55 52
56 53
57 54
58 55
59 56
60 57

1
2
3 1 *believe that, when using this placebo tool, I contribute to preventing patients from visiting other*
4 2 *specialists with their vague symptoms.”*
5
6 3

7 4 **GPs' cognitive factors**

9 5 GPs' mentioned cognitive barriers and facilitators for reducing the number of vitamin tests. These can
10 6 be summarised in two categories: (1) influence of the REVERT intervention on GPs' knowledge and
11 7 (2) conflicting medical information.
12 8

15 9 ***Influence of intervention on GPs' knowledge***

16 10 Up-to-date knowledge about the usefulness of vitamin tests, offered through the (online) education in
17 11 the REVERT study, was the most important facilitator for reducing vitamin testing according to the
18 12 GPs. GPs mentioned that, apart from the up-to-date knowledge, the concrete patient examples and
19 13 the background information about guideline-based indications for vitamin testing and treatment
20 14 discussed in the (online) education in the REVERT study also contributed to changing testing
21 15 behaviour regarding vitamin D and B12, because it was helpful in giving explanations to patients about
22 16 the usefulness of vitamin testing.
23 17

24 18 Lack of repetition of the information was mentioned as the most important cognitive barrier to
25 19 remembering, with the risk of falling back into old patterns of test ordering. Four GPs mentioned that it
26 20 was difficult to remember all the information received during the single moment of (online) education.
27 21 Nine GPs mentioned that it was easier to remember all the information if they had received other
28 22 education about this subject in the past or frequently discussed the topic in meetings with colleagues.
29 23

36 24 ***Conflicting medical information***

37 25 Conflicting results and recommendations from other information sources were mentioned as the most
38 26 important barrier to reducing the number of vitamin tests requested by GPs. About half of the GPs
39 27 mentioned these conflicting results in the literature about the association between symptoms and
40 28 vitamin levels as a problem in building up their argumentation during the patient consultation. They
41 29 also mentioned that global recommendations, sometimes differ from national guideline
42 30 recommendations. These inter-country differences were mentioned as a reason for discussion with
43 31 patients. Some GPs therefore thought it difficult to resist vitamin test requests from patients, especially
44 32 when patients' "knowledge" seemed to be better than their own knowledge on this topic.
45 33

50 34 *(GP5, woman, 37 years) 'GP does not feel confident enough about knowledge'*

51 35 *"It is still very difficult to translate the information that you received from (online) education to an*
52 36 *explanation for a very demanding patient in 10 minutes. Especially when the patient has searched for*
53 37 *a lot of different articles that emphasise the importance of vitamin testing.”*
54 38

55 39 As part of a sustainable strategy to reduce vitamin testing in general practice, GPs mentioned the
56 40 need for an overview of up-to-date knowledge about vitamin testing in a national guideline or protocol.
57
58
59
60

1
2
3 1 GPs thought that such a protocol would make it easier for health professionals to quickly search for
4 2 answers when unable to recall the information from previous (online) education.
5
6 3

7 4 *(GP4, woman, 38 years) 'Need for a protocol'*

8
9 5 "So, I needed some kind of protocol that included the 10 most important things that I had learnt during
10 6 the online education. I noticed that I had difficulty recalling information from previous sessions and
11 7 therefore returned."
12
13 8

9 **Social factors affecting GPs' testing behaviour**

10 GPs reported the following social factors affecting their testing-behaviour: (1) interaction with patients,
11 (2) attitudes of other health professionals, and (3) influence of media and society.
12

13 ***Interaction with patients***

14 GPs indicated that good communication skills are needed to provide explanations and to convince
15 patients that vitamin tests are not always necessary. GPs also mentioned that a low education level
16 and language barriers made it more difficult to communicate and that they regarded these as barriers
17 to providing a good explanation to patients on the limited usefulness of vitamin testing.
18

19 GPs mentioned that it was easier to convince patients with whom they had a long relationship
20 compared to patients who were relatively new in their general practice. One GP mentioned using her
21 seniority, due to her age, making it easier to convince patients to agree with non-testing.
22

23 ***Attitudes of other health professionals***

24 Six GPs mentioned that their partner GPs in the practice were less motivated to reduce unnecessary
25 vitamin tests or had different opinions about vitamin testing than themselves. Also, the presence of
26 locum doctors in the practice was mentioned as a barrier to reducing the number of vitamin tests
27 requested, because locums were found to request vitamin tests more often. In some practices,
28 assistants were able to request vitamin levels on their own initiative, limiting the reduction in vitamin
29 testing. On the other hand, four GPs reported that all the GPs in their practice had the same thoughts
30 and restrictive methods regarding vitamin testing. Furthermore, it was considered helpful if other
31 health professionals, e.g. GPs' assistants, had up-to-date knowledge about vitamin testing through
32 education in order to provide patients with the same message on the limited usefulness of vitamin
33 testing.
34

35 *(GP19, man, 35 years) 'Up-to-date knowledge among GPs' assistants*

36 "It is important that the assistants have the same knowledge as the GPs, because they are asked the
37 most questions about vitamin testing."
38

39 ***Influence of media and society***

59
60

1
2
3 1 Another reported factor that made it difficult to reduce vitamin tests is the information spread about the
4 2 suggested importance of unrestricted vitamin D and B12 tests by other healthcare professionals, the
5 3 social media, or other patients. In line with this, GPs suggested that more support from colleagues,
6 4 media, and society should be part of a sustainable strategy to reduce unnecessary vitamin tests. GPs
7 5 specifically mentioned the need for reliable information resources for patients.
8
9
10
11 6

7 **Patients' motivational factors**

8 Two components of patients' motivation to change behaviour could be distinguished: (1) attitudes
9 towards GPs and (2) attitudes towards vitamin testing.
10

11 **Attitudes towards GPs**

12 About half of the patients mentioned that they had a negative attitude on this subject towards their GP.
13 These patients were convinced that their GP did not have enough knowledge about vitamins (tests);
14 this resulted in distrust and dissatisfaction with the information provided and the decisions made by
15 their GP regarding vitamin testing.
16

17 *(P12, woman, 40 years) 'GP does not have enough knowledge'*

18 *"I decided to look up all the information I wanted to know, because my GP couldn't tell me much about*
19 *it, that was a pity. I think that I do know more about vitamin testing than my GP knows."*
20

21 **Attitudes towards vitamin testing**

22 Most of the patients also had a negative attitude towards a policy of 'not testing' and even suggested
23 that it would be better if GPs increased vitamin testing and paid more attention to vitamin deficiencies.
24 In line with a negative attitude towards 'not testing', about 50% of the patients reported not seeing any
25 alternative for vitamin blood tests. Moreover, they stated their dissatisfaction with GPs who were
26 unwilling to test their vitamin levels. Two patients mentioned that they would keep asking their GP for
27 vitamin tests until their request was met.
28

29 *(P5, woman, 53 years) 'Keep asking the GP for vitamin testing'*

30 *"The GP always disagrees with my requests for vitamin testing, saying: 'I don't think that vitamin*
31 *deficiency is the problem'. I have to be very demanding and in the end I get what I want."*
32

33 Some patients mentioned that they would accept a satisfactory explanation from their GP about the
34 reasons for not testing if the GP disagreed with their vitamin test request. Two patients suggested that
35 health professionals with a background in alternative medicine could be consulted as an alternative for
36 having vitamin levels in their blood tested when the GP disagreed with their request.
37

38 **Patients' cognitive factors**

59
60

1
2
3 1 Two components of cognition and knowledge about vitamin (testing) can be identified in patients: (1)
4 2 thoughts and attitudes regarding information sources and (2) patients' reasons for wanting to be
5 3 tested.
6 4

5 **Thoughts and attitudes regarding information sources**

6 Most of the patients used the internet to search for information about vitamins. Five patients had read
7 information about vitamins in books and magazines. Psychological symptoms, myalgia, and fatigue
8 were the most frequently mentioned symptoms associated with vitamin D and B12 deficiencies.
9 Patients mentioned that the information that they found on the association between vitamin
10 deficiencies and symptoms gave them an explanation for their symptoms.
11

12 *(P17, woman 31 years) 'Online information sources'*

13 *"I decided to look online for more information and I recognised a lot of my symptoms in the stories that*
14 *I read on the internet."*
15

16 Patients thought it confusing that there are differences between reference levels and advices between
17 countries and study results. They mentioned that these differences made it more difficult to believe
18 that their GP's reference levels were correct.
19

20 **Patients' reasons for wanting to be tested**

21 Patients' main reason for asking their GP to have their vitamin levels tested was fatigue. Other
22 reasons mentioned were depressive symptoms, weight loss, and myalgia. A vegetarian or vegan diet
23 was also mentioned as a reason for having a vitamin B12 test. Some patients mentioned that a history
24 of vitamin deficiency strengthened their request to have their vitamin D and/or B12 levels tested.
25
26

27 **Discussion**

28 29 **Summary of key findings**

30 In this qualitative analysis, we found a wide spectrum of patient- and GP-related perceptions and
31 attitudes that affect vitamin test ordering in clinical practice (summarised in Figure 1). The most
32 important factors hampering vitamin test reduction programmes are the mismatch between patients
33 and medical professionals regarding the presumed indications for testing for vitamin D and B12,
34 differences in motivation, and the GPs' tendency to avoid conflict. The most important facilitator for
35 vitamin test reduction programmes is updating GPs' knowledge about test indications in combination
36 with improving their awareness of their individual test behaviour.
37

38 *Reasons for testing differed between patients and GPs.*

39 For patients, the most important reasons to ask for vitamin testing were (non-specific) medical
40 symptoms based on information found on the internet and confirmed by other media, contacts, and

1
2
3 1 sometimes other healthcare professionals. GPs, however, mentioned being aware of the lack of
4 2 indication for vitamin testing when patients presented with non-specific medical symptoms.
5
6 3

7 4 GPs used information from the (online) project education to rebut patients' ideas and explain about the
8 5 limited usefulness of vitamin testing. Conflicting results and recommendations between different
9 6 information sources result in confusion about indications and the usefulness of vitamin testing among
10 7 both GPs and patients, creating discussion between GP and patients. A difference between patients
11 8 and GPs in their motivation to change testing behaviour was also identified. Whereas most GPs were
12 9 very motivated to reduce vitamin testing, most patients suggested that it would be better if GPs tested
13 10 more frequently for vitamin deficiencies in general practice.
14
15
16
17 11

18
19 12 Another barrier to reducing the number of vitamin tests was GPs' tendency to avoid conflict and satisfy
20 13 patients in order to foster good relationships with patients. In line with this, good communication skills
21 14 facilitated GPs in discussing and explaining the limited usefulness of vitamin testing to patients.
22
23 15

24 16 Other facilitators for reducing the number of vitamin tests according to GPs were consensus between
25 17 healthcare professionals and ongoing feedback on testing behaviour, but almost all GPs mentioned
26 18 up-to-date knowledge about the usefulness of vitamin testing through education as the most important
27 19 facilitator for reducing vitamin tests.
28
29
30 20

31 21 Following from this, to enable GPs to recall information, a reliable overview of the evidence and
32 22 recommendations regarding vitamin testing is warranted. GPs mentioned that this knowledge should
33 23 also be available to other healthcare professionals and patients in order to create unanimity about the
34 24 usefulness of vitamin tests. GPs also suggested getting regular individual feedback about their testing
35 25 behaviour to keep them motivated to test only when necessary and to have a tool to remind them to
36 26 change their testing behaviour.
37
38
39
40 27

41 28 **Results in context**

42 29 Patients and GPs having conflicting information was one of the main barriers to reducing unnecessary
43 30 vitamin testing. In line with our results, previous research has highlighted that not only health
44 31 professionals, but also the media, are key information providers on this topic for patients.²⁰ A media
45 32 content analysis showed that news articles linked vitamin D to a wide range of health conditions
46 33 without conclusive scientific evidence.²¹ As reflected by our study as well as previous research, this
47 34 has resulted in confusion regarding the usefulness of vitamin testing, among both patients and GPs.⁹
48 35 ²² Moreover, GPs' information sources also present conflicting results, reinforcing this confusion. To
49 36 counter this, previous research highlighted the need for clear information that reflects the actual state
50 37 of knowledge and for ongoing research for both healthcare professionals and patients.^{9, 10, 20} Similarly,
51 38 GPs in this study mentioned that clear guidelines for patients and GPs regarding vitamin testing would
52 39 help them in discussions with their patients. In line with this, in this study education was found as one
53 40 the most important facilitators for reducing vitamin testing. Previous research showed that education
54
55
56
57
58
59
60

1 and communication through electronic educational codified comments might improve vitamin
2 requests.²³ In addition, strategies for reducing unnecessary vitamin testing require continuous
3 education, because the intervention-effect of education seems to decrease over time.²⁴

4
5 Feedback on testing behaviour was found to be another important facilitator for reducing the number
6 of unnecessary vitamin tests. This is in line with an RCT that showed that feedback of requesting rates
7 was an effective strategy for reducing laboratory testing in primary care.²⁵ The results of a systematic
8 review suggest that feedback may be more effective when it is provided more than once and when it
9 includes both measurable targets and an action plan.²⁶ These suggestions could be useful for
10 implementing feedback on testing behaviour in the future. GPs suggested that feedback on individual
11 GP behaviour might be more effective than feedback on practice level. Such individual feedback might
12 contribute to the measurability of targets and a personalised action plan.

13 14 **Strengths and limitations**

15 This is the first study to use semi-structured interviews to explore the barriers and facilitators for
16 reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered. The qualitative
17 approach and the use of open-coding based on a broad theoretical framework allowed us to highlight
18 all the different aspects behind the complexity of reducing vitamin testing. The validity and reliability of
19 this study were strengthened by including patients from a broad range of backgrounds, as well as GPs
20 from 20 different practices.

21
22 Still, a few limitations need to be addressed. First, participating GPs were affiliated to a research
23 network and therefore might not have been representative of all GPs in the Netherlands. Next, patients
24 were invited for the interviews by their GPs; this creates a potential bias arising from the selection of,
25 for example, more outspoken patients. However, patient characteristics (Table 1) show large variation
26 in age, sex, and educational level, making inclusion of different patient perspectives likely. Finally,
27 even though the same interview guide was used, the interviews in this study were performed by two
28 different researchers, who may have had differences in their interviewing style that may have
29 influenced participants' responses.

30 31 **Recommendations**

32 From a GP's perspective, a sustainable reduction in vitamin test requests in primary care requires the
33 following steps: (1) updating GPs' knowledge through (online) education, (2) guidelines with clear and
34 uniform recommendations on prevailing indications for vitamin testing and supplementation for all
35 healthcare professionals, and (3) regular (individual) feedback on GPs' test behaviour.

36
37 From a societal perspective, access to clear and reliable information on vitamin testing for the
38 population is needed, from trustful sources. In addition, the spread of non-evidence-based information
39 through lay media should be challenged. Further research is required to measure the effect of these
40 strategies on reducing vitamin testing.

Conclusion

In conclusion, conflicting information about the usefulness of vitamin testing, differences in motivation between patients and GPs, as well as GPs' tendency to avoid conflict and to satisfy patients are important barriers to reducing the number of vitamin tests. Nevertheless, updating GPs' knowledge, feedback on GPs' testing behaviour, and guidelines with clear recommendations for all healthcare professionals (including patient information) on prevailing indications for vitamin testing and supplementation could facilitate a sustainable reduction in vitamin testing in primary care.

Acknowledgements

We would like to thank the entire REVERT team for their diligence, expertise and enthusiasm. Finally, we are indebted to all patients and GPs who consented to be interviewed, without whom this study would not have been possible.

Figure 1. Patient- and GP-related perceptions and attitudes affecting vitamin test ordering in clinical practice

1 References

- 1 Sattar N, Welsh P, Panarelli M, et al. Increasing requests for vitamin D measurement: costly, confusing, and without credibility. *The Lancet* 2012;379:95–6.
- 2 Franken P, Geutjes P, van den Ouweland J, et al. Diagnose van vitamine-B12-tekort. *Huisarts en wetenschap* 2015;58:530–1.
- 3 Medicare Payments for Clinical Diagnostic Laboratory Tests in 2016: Year 3 of Baseline Data 2017. <https://oig.hhs.gov/oei/reports/oei-09-17-00140.asp>.
- 4 Bilinski K, Boyages S. Evidence of overtesting for vitamin D in Australia: an analysis of 4.5 years of Medicare Benefits Schedule (MBS) data. *BMJ Open* 2013;3:e002955. doi: 10.1136/bmjopen-2013-002955
- 5 LeFevre ML, LeFevre NM. Vitamin D Screening and Supplementation in Community-Dwelling Adults: Common Questions and Answers. *Am Fam Physician* 2018;97(4):254-60.
- 6 Bindels PJ. Vitamin D: what to do with it? *Ned Tijdschr Geneesk* 2015;159:A8837.
- 7 Langan RC, Goodbred AJ. Vitamin B 12 Deficiency: Recognition and Management. *Am Fam Physician* 2017;96:384–89.
- 8 Moynihan R, Doust J, Henry D. Preventing overdiagnosis: how to stop harming the healthy. *BMJ: British Medical Journal (Online)* 2012;344:e3502. doi: 10.1136/bmj.e3502.
- 9 Kotta S, Gadhvi D, Jakeways N, et al. "Test me and treat me"-attitudes to vitamin D deficiency and supplementation: a qualitative study. *BMJ Open* 2015;5: e007401. doi:10.1136/bmjopen-2014-007401
- 10 Gowda U, Smith BJ, Wluka AE, et al. Vitamin D testing patterns among general practitioners in a major Victorian primary health care service. *Aust N Z J Public Health* 2016;40:144–7.
- 11 Rodriguez-Borja E, Corchon-Peyrallo A, Barba-Serrano E, et al. "Send & hold" clinical decision support rules improvement to reduce unnecessary testing of vitamins A, E, K, B1, B2, B3, B6 and C. *Clinical Chemistry and Laboratory Medicine (CCLM)* 2018;56:1063-70.
- 12 Michiels-Corsten M, Donner-Banzhoff N. Beyond accuracy: hidden motives in diagnostic testing. *Fam Pract* 2018;35;222–7.
- 13 Haijaj FM, Salek MS, Basra MK, et al. Non-clinical influences on clinical decision-making: a major challenge to evidence-based practice. *J R Soc Med* 2010;103:178-87.

- 1
2
3 14 O'Brien BC, Harris IB, Beckman TJ, et al. Standards for reporting qualitative research: a synthesis
4 of recommendations. *Acad Med* 2014;89:1245-51. doi:10.1097/ACM.0000000000000388.
5
6
7 15 Charmaz K. *Constructing grounded theory: A practical guide through qualitative analysis*. Sage
8 2006.
9
10
11 16 Grol R, Wensing M, Bosch M, et al. Theories on implementation of change in healthcare. *Improving*
12 *Patient Care: The Implementation of Change in Health Care, Second Edition* 2013:18–39.
13
14
15 17 Social and Cultural office [Sociaal en Cultureel Planbureau], Social economic factors
16 [Statusscores]. 2009.
17
18
19 18 Guest G, Bunce A, Johnson L. How many interviews are enough? An experiment with data
20 saturation and variability. *Field Methods* 2006;18:59–82.
21
22
23 19 Zamawe FC. The implication of using NVivo software in qualitative data analysis: Evidence-based
24 reflections. *Malawi Medical Journal* 2015;27:13–15.
25
26
27 20 Deschasaux M, Souberbielle J, Partula V, et al. What do people know and believe about vitamin
28 D?. *Nutrients* 2016;8:718.
29
30
31 21 Caulfield T, Clark MI, McCormack JP, et al. Representations of the health value of vitamin D
32 supplementation in newspapers: media content analysis. *BMJ Open* 2014;4: e006395. doi:10.1136/
33 bmjopen-2014-006395.
34
35
36 22 Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient
37 management of health and uncertainty. *Qual Health Res* 2014;24:375–86.
38
39
40 23 Salinas M, López-Garrigós M, Flores E, et al. Education and communication is the key for the
41 successful management of vitamin D test requesting. *Biochemia medica: Biochemia medica*
42 2015;25:237-41.
43
44
45 24 Miyakis S, Karamanof G, Lontos M, et al. Factors contributing to inappropriate ordering of tests in
46 an academic medical department and the effect of an educational feedback strategy. *Postgrad Med J*
47 2006;82:823-9 doi:82/974/823.
48
49
50 25 Thomas RE, Croal BL, Ramsay C, et al. Effect of enhanced feedback and brief educational
51 reminder messages on laboratory test requesting in primary care: a cluster randomised trial. *The*
52 *Lancet* 2006;367:1990–6.
53
54
55 26 Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and
56 healthcare outcomes. *Cochrane Database of Systematic Reviews* 2012. Issue 6. Art. No.: CD000259.
57
58
59 DOI: 10.1002/14651858.CD000259.pub3.
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

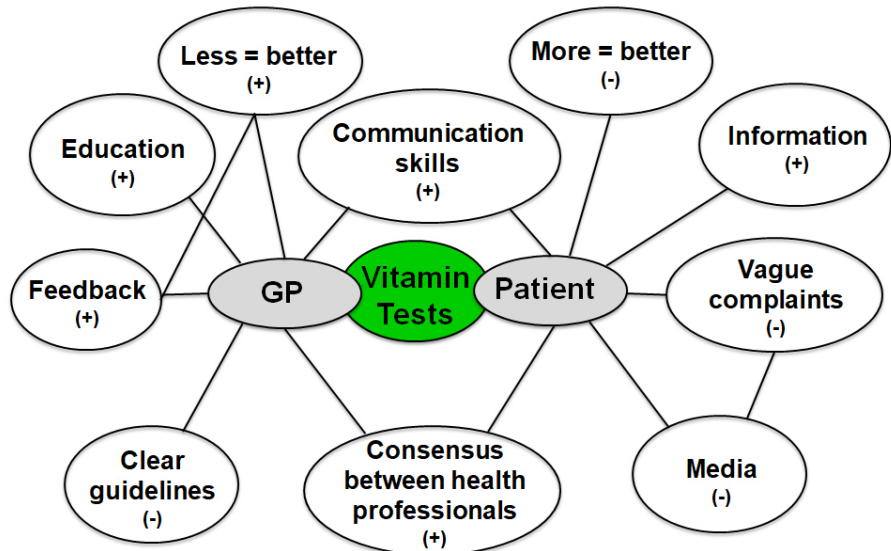


Figure 1. Patient- and GP-related perceptions and attitudes affecting vitamin test ordering in clinical practice.

90x60mm (300 x 300 DPI)

Reporting checklist for qualitative study.

Based on the SRQR guidelines.

		Reporting Item	Page Number
	#1	Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g. ethnography, grounded theory) or data collection methods (e.g. interview, focus group) is recommended	4
	#2	Summary of the key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results and conclusions	2
Problem formulation	#3	Description and significance of the problem / phenomenon studied: review of relevant theory and empirical work; problem statement	3, 4
Purpose or research question	#4	Purpose of the study and specific objectives or questions	4
Qualitative approach and research paradigm	#5	Qualitative approach (e.g. ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g. postpositivist, constructivist /	4, 5, 6

interpretivist) is also recommended; rationale. The rationale should briefly discuss the justification for choosing that theory, approach, method or technique rather than other options available; the assumptions and limitations implicit in those choices and how those choices influence study conclusions and transferability. As appropriate the rationale for several items might be discussed together.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35	Researcher characteristics and reflexivity	#6	Researchers' characteristics that may influence the research, including personal attributes, qualifications / experience, relationship with participants, assumptions and / or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results and / or transferability	5
36 37 38	Context	#7	Setting / site and salient contextual factors; rationale	4, 5
39 40 41 42 43 44 45 46 47 48	Sampling strategy	#8	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g. sampling saturation); rationale	5, 6
49 50 51 52 53 54 55 56 57 58 59 60	Ethical issues pertaining to human subjects	#9	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	3

1	Data collection methods	#10	Types of data collected; details of data collection	5, 6
2				
3			procedures including (as appropriate) start and stop	
4			dates of data collection and analysis, iterative process,	
5			triangulation of sources / methods, and modification of	
6			procedures in response to evolving study findings;	
7			rationale	
8				
9				
10				
11				
12				
13				
14				
15	Data collection	#11	Description of instruments (e.g. interview guides,	5, 6
16				
17	instruments and		questionnaires) and devices (e.g. audio recorders) used	
18			for data collection; if / how the instruments(s) changed	
19	technologies		over the course of the study	
20				
21				
22				
23				
24				
25	Units of study	#12	Number and relevant characteristics of participants,	5, 6
26			documents, or events included in the study; level of	
27			participation (could be reported in results)	
28				
29				
30				
31				
32				
33	Data processing	#13	Methods for processing data prior to and during	5, 6
34				
35			analysis, including transcription, data entry, data	
36			management and security, verification of data integrity,	
37			data coding, and anonymisation / deidentification of	
38			excerpts	
39				
40				
41				
42				
43				
44				
45	Data analysis	#14	Process by which inferences, themes, etc. were	6
46				
47			identified and developed, including the researchers	
48			involved in data analysis; usually references a specific	
49			paradigm or approach; rationale	
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

1	Techniques to enhance	#15	Techniques to enhance trustworthiness and credibility	5, 6
2				
3	trustworthiness		of data analysis (e.g. member checking, audit trail,	
4			triangulation); rationale	
5				
6				
7				
8	Syntheses and	#16	Main findings (e.g. interpretations, inferences, and	6-13
9			themes); might include development of a theory or	
10	interpretation		model, or integration with prior research or theory	
11				
12				
13				
14				
15				
16	Links to empirical data	#17	Evidence (e.g. quotes, field notes, text excerpts,	8-13
17			photographs) to substantiate analytic findings	
18				
19				
20				
21				
22	Intergration with prior	#18	Short summary of main findings; explanation of how	13-16
23			findings and conclusions connect to, support, elaborate	
24	work, implications,		on, or challenge conclusions of earlier scholarship;	
25			discussion of scope of application / generalizability;	
26	transferability and		identification of unique contributions(s) to scholarship in	
27			a discipline or field	
28	contribution(s) to the			
29	field			
30				
31				
32				
33				
34				
35				
36	Limitations	#19	Trustworthiness and limitations of findings	15
37				
38				
39	Conflicts of interest	#20	Potential sources of influence of perceived influence on	1
40			study conduct and conclusions; how these were	
41			managed	
42				
43				
44				
45				
46				
47	Funding	#21	Sources of funding and other support; role of funders in	1
48			data collection, interpretation and reporting	
49				
50				
51				

The SRQR checklist is distributed with permission of Wolters Kluwer © 2014 by the Association of American Medical Colleges. This checklist was completed on 02. February 2019 using

1 <https://www.goodreports.org/>, a tool made by the [EQUATOR Network](#) in collaboration with

2
3 [Penelope.ai](#)
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

BMJ Open

Reducing unnecessary vitamin testing in general practice: barriers and facilitators according to general practitioners and patients.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2019-029760.R2
Article Type:	Research
Date Submitted by the Author:	14-Aug-2019
Complete List of Authors:	Hofstede, Hetty; Department of General Practice, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands, van der Burg, Rosalie; Erasmus MC, University Medical Center Rotterdam, Department of General Practice Mulder, Bob; Wageningen University, Strategic Communication group, Wageningen, The Netherlands Bohnen, Arthur; Erasmus MC, University Medical Center Rotterdam, Department of General Practice Bindels, Patrick; Erasmus MC, University Medical Center Rotterdam, Department of General Practice de Wit, Niek; University Medical Center Utrecht, Julius Center for Primary Care de Schepper, E; Erasmus MC, University Medical Center Rotterdam, Department of General Practice van Vugt, Saskia; Department of General Practice, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, The Netherlands
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Diagnostics, Patient-centred medicine, Communication
Keywords:	Vitamin D [Mesh], Diagnostic tests [Mesh], General practice [Mesh], Qualitative Research [Mesh], Vitamin B 12 [Mesh]

SCHOLARONE™
Manuscripts

1
2
3 1 Technical appendix and statistical code available from the corresponding author at
4 2 S.F.vanVugt@umcutrecht.nl
5
6
7 3

4 **Abstract**

5 6 **Objective**

7 There has been an increase in testing of vitamins in patients in general practice, often based on
8 irrational indications or for non-specific symptoms, causing increasing healthcare expenditures and
9 medicalisation of patients. So far, there is little evidence of effective strategies to reduce this over-
10 testing in general practice. Therefore, the aim of this qualitative study was to explore the barriers and
11 facilitators for reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered.
12

13 **Design and setting**

14 This qualitative study, based on a grounded theory design, used semi-structured interviews among
15 general practitioners (GPs) and patients from two primary care networks (147 GPs; 195,000 patients).
16 These networks participated in the REVERT study (REducing Vitamin tEsting in pRimary care
17 practice), an RCT evaluating intervention strategies to reduce test ordering in primary care in the
18 Netherlands.
19

20 **Participants**

21 Twenty-one GPs, with a maximum of 1 GP per practice that took part in the REVERT study, and 22
22 patients (who were invited by their GP during vitamin-related consultations) were recruited, from which
23 20 GPs and 19 patients agreed to participate in this study.
24

25 **Results**

26 The most important factor hampering vitamin-test reduction programmes is the mismatch between
27 patients and medical professionals regarding the presumed appropriate indications for testing for
28 vitamin D and B12. In contrast, the most important facilitator for vitamin-test reduction may be
29 updating GPs' knowledge about test indications and their awareness of their own testing-behaviour.
30

31 **Conclusions**

32 To achieve a sustainable reduction in vitamin testing, guidelines with clear and uniform
33 recommendations on evidence-based indications for vitamin testing, combined with regular (individual)
34 feedback on test-ordering behaviour, are needed. Moreover, the general public need access to clear
35 and reliable information on vitamin testing. Further research is required to measure the effect of these
36 strategies on the number of vitamin test requests.
37

1
2
3 1 **Keywords:** Qualitative Research [Mesh], General practice [Mesh], Diagnostic tests [Mesh], Vitamin D
4 2 [Mesh], Vitamin B 12 [Mesh].
5
6 3

7 4 **Trial registration number:** This study was deemed by the University Medical Center Utrecht ethics
8 5 committee not to be subject to full assessment (protocol number WAG/mb/16/039555).
9
10 6

11 7 **Strengths and limitations of this study**

- 12 8 • This is the first study using semi-structured interviews to explore the barriers and facilitators
13 9 for reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered.
 - 14 10 • A qualitative approach with the use of open-coding allows all different aspects behind the
15 11 complexity of reducing vitamin testing to be addressed.
 - 16 12 • Potential bias due to selection of GPs affiliated to a research network and selection of patients
17 13 by their GPs.
- 18
19
20
21
22
23
24
25
26
27
28
29
30
31

32 16 **Introduction**

33 18 The number of vitamin tests ordered in general practice has increased substantially in developed
34 19 countries in recent years.¹ For example, the regional number of test requests for vitamin B12 in
35 20 Utrecht, the Netherlands, increased almost sixfold between 2004 and 2014.² Vitamin D was the fifth
36 21 most common laboratory test ordered for Medicare patients in the US in 2016, at a total cost of
37 22 US\$350 million.³
38
39
40

41 24 Most indications for these tests are probably not evidence based, as a causal relationship with vitamin
42 25 deficiencies for most health conditions is not present.^{4, 5} This over-testing could result in over-
43 26 diagnosis and overtreatment with vitamin supplements, further increasing medicalisation, increasing
44 27 healthcare costs, and irrational health perceptions.^{1, 5-7, 8} For example, previous research concluded
45 28 that, although vitamin testing may potentially be useful in some high-risk groups, over-testing and
46 29 overtreatment of vitamin D by general practitioners (GPs) resulted in professional and societal
47 30 medicalisation of vitamin D.⁹ To counter this inappropriate medicalisation, a long-term strategy to
48 31 reduce over-testing and over-supplementation is needed.^{9, 10}
49
50
51
52
53

54 33 So far, there is little evidence of effective strategies to reduce this over-testing in general practice,
55 34 although clinical decision support rules seem promising.¹¹ Understanding barriers to, and facilitators
56 35 for, reducing over-testing is essential to develop a long-term strategy to tackle this problem.¹⁰ For
57 36 instance, Moynihan et al. suggested that 'commercial and professional vested interests' and 'cultural
58 37 beliefs that more is better' are facilitators of diagnostic testing that can lead to overdiagnosis.⁸
59
60

1
2
3 1 Furthermore, a qualitative study examining GPs' hidden motives in diagnostic decision making
4 2 concluded that patients' reassurance was a strong motivation for GPs to perform or order diagnostic
5 3 tests.¹² Next to GP related factors, many patient related factors may influence clinical decision.¹³
6 4

7 5 So far, theoretical perspectives as well as empirical studies on the barriers and facilitators of vitamin
8 6 test ordering in general practice are lacking. Therefore, we performed a qualitative assessment using
9 7 semi-structured interviews among both GPs and patients to explore the barriers and facilitators for
10 8 reducing the number of unnecessary ordered vitamin D and B12 laboratory tests.
11 9

12 10

13 11 **Method**

14 12 **Design and setting**

15 13 SRQR reporting guidelines were used for this qualitative study.¹⁴ This qualitative study used a
16 14 grounded theory design,¹⁵ because this design is explicitly suited for examining how meanings in
17 15 people's perceptions are related to their actions. Applied to our study, using grounded theory allowed
18 16 us to study how meanings attached to vitamin testing interrelate to choices and actions regarding
19 17 vitamin testing, for both GPs and patients. The aim is, ultimately, to develop new theoretical concepts,
20 18 grounded in qualitative data, which represent barriers and facilitators for vitamin testing. These new
21 19 theoretical concepts may be further developed and tested in future research.
22 20

23 21 Data were collected through semi-structured interviews among GPs and patients from two primary
24 22 care networks in the Netherlands that participated in the REVERT study (REducing Vitamin tEsting in
25 23 pRimary care pracTice). The REVERT study was an RCT assessing the effectiveness of a GP
26 24 intervention programme including education, monitoring, and feedback on numbers in relation to
27 25 ordering vitamin D and B12 tests. Four times a year, GPs received feedback on the number of tests
28 26 they ordered. After randomisation, half of all participating practices also received patient information
29 27 on vitamin testing. In total, 22 general practices (117 GPs with 134,000 patients) in the Utrecht region
30 28 and 4 health centres (41 GPs and 61,000 patients) in the Rotterdam region participated in the
31 29 REVERT study (van Vugt SF, de Schepper EIT, van Delft S. et al. Reducing vitamin test ordering in
32 30 primary care: the effectiveness of a professional and patient oriented strategy).
33 31
34 32

35 33 **Recruitment of participants**

36 34 At the end of the one-year intervention period, we have invited all participating general practices for an
37 35 interview by telephone or face to face by one of the researchers. To secure an adequate case mix
38 36 regarding practice type and socioeconomic status of the practice area, only 1 general practitioner per
39 37 REVERT practice was invited for an interview.
40 38

41 39 Patients were recruited through the participating GPs; GPs were asked to invite patients during
42 40 consultations in which vitamin testing was a topic of conversation. The GPs asked them if they were

1 willing to be interviewed about vitamin testing. When patients consented to be interviewed on this
2 topic, GPs provided the patients' name and telephone number to the researchers, who contacted the
3 patients. We aimed to recruit a mixed sample in terms of age, gender, ethnicity and educational level,
4 because large variation as to demographic characteristics helps to recruit a sample with the widest
5 range of possible experiences, opinions and preferences. This is necessary for a full exploration of this
6 issue.

8 **Data collection**

9 The interviews were performed by two interviewers (HH, RB), during the last quartile of the
10 intervention period of the REVERT study. The interviewers were two master's medical students with a
11 background in medical research and/or qualitative research, supported by a multidisciplinary team of
12 researchers, GPs, and a psychologist specialized in communication research (BM). BM trained HH
13 and RB in how to apply guidelines for doing in-depth interviews.

14 The GP interviews were conducted face-to-face in the GPs' office, and the patient interviews
15 were conducted by telephone. Interviews lasted approximately 30 minutes and 15 minutes for GPs
16 and patients, respectively, and were semi-structured using a list that covered four broad topics of
17 barriers and facilitators for reducing the number of (unnecessary) vitamin D and B12 testing. The four
18 topics were based on the framework by Grol and Wensing¹⁶, namely: 1) perceptions of, and reasons
19 for, vitamin D and B12 testing; 2) cognitive, motivational, and social factors potentially influencing the
20 number of vitamin tests ordered;¹⁶ 3) evaluation of the study intervention (e-module, education, and
21 feedback); 4) ideas regarding a successful strategy for a durable reduction in vitamin test ordering.
22 Baseline characteristics of GPs (sex, age, years working as GP, intervention group (de-
23 implementation strategy 1 or 2), and patients (sex, age, and education level) were ascertained at the
24 end of the interview. Data on number of patients per practice were retrieved by emailing the practices.
25 In addition, data on socioeconomic status (SES) were retrieved from the Social and Cultural Planning
26 Office (SCP) in the Netherlands and linked to our data through the four digits of the postal codes of the
27 practice area. SCP calculates socioeconomic status scores based on information concerning
28 education, income, and position in the labour market.¹⁷ We expected interviews with 20 GPs and 20
29 patients to be sufficient for item saturation.¹⁸ During data collection, interim meetings were held with
30 the interviewers (HH, RB) and psychologist (BM) to discuss data and monitor progress towards
31 saturation.

32 Based on a previous study, we expected a minimum of approximately 12 interviews with GPs
33 and 12 interviews with patients to be sufficient for saturation,¹⁸ although numbers mentioned in the
34 literature vary, and thus cannot be taken as absolute indicators of saturation or any other criterium. To
35 guarantee at least 12 interviews per group, the aim was to organise about 20 interviews with GPs and
36 20 interviews with patients. Twenty-one GPs from different practices were invited to participate. One
37 GP declined, so in total 20 GPs agreed to participate in this study (5 GPs in Rotterdam and 15 GPs in
38 Utrecht). Of the 22 patients who consented to participate in the study, 3 could not be reached by
39 telephone by the researchers, resulting in 19 interviewed patients.

1 **Data analysis**

2 The interviews were recorded on audiotape and transcribed verbatim. Next, these data were coded
3 combining a deductive (i.e. Grol and Wensing's framework)¹⁶ and an inductive (i.e. data-driven)
4 approach, using QSR NVivo (version 11).¹⁹ All interviews were coded independently by two
5 researchers (HH and RB). The emerging themes were continuously compared with interview
6 transcripts. During data collection, interim meetings were held with the interviewers (HH, RB) and
7 communication researcher (BM) to discuss data collection and analysis, including emerging themes
8 and how these interrelated. The assigned codes and themes were discussed by the coding
9 researchers until consensus was achieved.

10 Data saturation was monitored and discussed as well. After coding 14 interviews for the GP
11 group and 14 interviews for the patient group, no new codes were added, which means that data
12 saturation was reached at that point.

14 **Patient and public involvement**

15 Patients and or public were not involved in the design, recruitment and conduct of the study.

18 **Results**

20 **Participants**

21 The characteristics of the 20 GPs and 19 patients who participated in the study are summarised in
22 Table 1.
23

Table 1. Baseline characteristics of included general practitioners and patients

	GP (n=20) Mean ± SD / n (%)		Patients (n=19) Mean ± SD / n (%)
Sex (female, n (%))	14 (70.0)	Sex (female, n (%))	17 (89.5)
Age (years, mean ± SD)	45.8 ± 9.9	Age (years, mean ± SD)	42.6 ± 13.9
Practice experience as GP (years, mean ± SD)	14.4 ± 10.0	Educational level ² (high, n (%))	13 (68.4)
Number of patients in practice (mean ± SD)	6807 ± 3104	Requested for vitamin B12 (yes, n (%))	11 (57.9)
Socioeconomic status of patients in practice ¹	0.59 ± 1.04	Requested for vitamin D (yes, n (%))	16 (84.2)
Intervention			
Online education (yes, n (%))	12 (60.0)		
Education vitamin testing (yes, n (%))	12 (60.0)		
Communication training (yes, n (%))	13 (65.0)		
Received feedback (yes, n (%))	16 (80.0)		
Patient information (yes, n (%))	11 (55.0)		

¹ Socioeconomic status data were retrieved from the Social and Cultural Planning Office (SCP) and linked by four digital postal codes to our data. SCP calculates social economic status scores based on information regarding education, income and position in the labour market. A socioeconomic status score of 0 defines the mean socioeconomic status in the Netherlands. A score > 0 defines a socioeconomic status higher than the mean in the Netherlands. A score < 0 defines a socioeconomic status lower than the mean in the Netherlands.

² A high educational level was defined as an academic bachelor degree or higher.

2 GPs' reasons for testing

3 Two categories of reasons for testing could be distinguished: (1) medical reasons and (2) non-medical
4 reasons. These reasons for testing were influenced by (3) participation in the REVERT study.

6 **Medical reasons**

7 Patients considered to be at high-risk of vitamin-D deficiency (e.g. a dark skin) was most often
8 mentioned as a medical reason. Medical reasons for testing vitamin B12 levels were a low
9 haemoglobin level, neuropathic symptoms, and a potentially insufficient diet. GPs reported testing
10 vitamin D levels for non-specific symptoms (e.g. fatigue or myalgia) only in a minority of patients, or if
11 patients insisted on having their vitamin levels tested.

12 **Non-medical reasons**

13 Maintaining a good relationship with the patient, avoiding conflict, and creating goodwill for follow-up
14 consultations were mentioned both for vitamin D and B12 testing. These non-medical reasons were
15 important arguments to order the test, if patients persisted in their request to have their vitamin B12 or
16 D levels tested, despite adequate explanation by the GP.

17
18 *(GP1, woman, 31 years) 'Creating goodwill for follow-up consultations'*

19 *"You can't refuse every request, because that will not improve your relationship with the patient. You
20 will create goodwill, when you agree with some requests from the patients. As a consequence, they
21 will trust you more and they will agree with your advices in follow-up consultations, instead of refusing
22 them."*

24 **Influence of participation in REVERT study**

25 Most of the GPs mentioned that they reduced their vitamin D and B12 test ordering as a result of
26 participation in the REVERT study. They reported investing more time during the consultation in
27 explaining vitamin test indications and discussing reasons for not testing, after having followed the
28 education on vitamin testing.

29
30 About half of the GPs advised their patients to supplement vitamin D instead of having their vitamin D
31 level tested. A few GPs reported that they did not change much in their testing behaviour. They
32 indicated that, before participation in REVERT, they rarely tested vitamin levels.

33
34 *(GP11, man, 43 years) 'Advice to supplement vitamin D instead of testing'*

35 *"Now I tell patients that they could start with supplements if they think that there is an association
36 between their symptoms and a vitamin deficiency. Just start with supplements."*

37
38 *(GP7, woman, 65 years) 'Spending more time explaining'*

39 *"I give patients more information and explanation at this moment. I always tested vitamin D and B12
40 levels in patients complaining of fatigue before I received education. I don't do that anymore."*

1
2
3 1
4
5 2

GPs' motivational factors

3 Regarding the motivation to reduce unnecessary vitamin tests, three aspects could be identified: (1)
4 ideas and attitudes towards the usefulness of reducing vitamin tests, (2) attitudes towards the effort to
5 change testing behaviour, and (3) influence of intervention on motivation to change testing behaviour.

6
7

Ideas and attitudes towards the usefulness of reducing vitamin tests

8 Most of the GPs considered reduction of unnecessary vitamin testing as beneficial. These GPs
9 believed that they improved healthcare quality and cost efficiency by reducing unnecessary vitamin
10 tests, through preventing medicalisation of patients and/or reducing healthcare costs.

11
12

Attitudes towards the effort to change behaviour

13 Some GPs were not motivated to change their testing behaviour because they expected the resulting
14 reduction in healthcare costs to be disappointing. Another aspect of some GPs' negative attitude
15 towards reducing vitamin testing was their observation that symptoms in deficient patients were
16 resolved after they started vitamin D supplementation. One GP mentioned vitamin testing as being
17 helpful by using a 'proven low vitamin level' as 'placebo tool', being a substrate or explanation for their
18 symptoms.

19
20

Influence of intervention on motivation to change testing behaviour

21 GPs mentioned that feedback of their testing behaviour in the REVERT project helped them to stay
22 motivated to reduce unnecessary vitamin testing. For a sustainable strategy to reduce test ordering,
23 GPs suggested retaining this feedback on testing behaviour. Individual feedback instead of feedback
24 on the practice's performance might be more effective because it could create more insight into GPs'
25 personal test-ordering behaviour.

26
27

27 *(GP10, woman, 48 years) 'Preventing medicalisation'*

28 *"I think that if you continue with over-testing vitamin levels, you are giving patients the idea that vitamin*
29 *testing is very useful. When you stop over-testing vitamin levels, you will stimulate patients to reflect*
30 *on their total well-being instead of only requesting laboratory testing."*

31
32

32 *(GP13, man, 57 years) 'Awareness of testing behaviour'*

33 *"When you request laboratory tests, you have no idea about the number of requests you make. It*
34 *appears to be a lot more than you think. I didn't expect that."*

35
36

36 *(GP3, man, 34 years) 'Proven low vitamin level as placebo tool'*

37 *"It is a kind of tool which I can use and I don't want to lose that tool. I sometime use it as placebo. I'd*
38 *like to use this tool, because I think that I can help patients by saying that their symptoms might be*
39 *due to a low vitamin level and that the symptoms might disappear when they start with supplements. I*

59
60

1
2
3 1 *believe that, when using this placebo tool, I contribute to preventing patients from visiting other*
4 2 *specialists with their vague symptoms.”*
5
6 3

7 4 **GPs' cognitive factors**

9 5 GPs' mentioned cognitive barriers and facilitators for reducing the number of vitamin tests. These can
10 6 be summarised in two categories: (1) influence of the REVERT intervention on GPs' knowledge and
11 7 (2) conflicting medical information.
12 8

15 9 ***Influence of intervention on GPs' knowledge***

16 10 Up-to-date knowledge about the usefulness of vitamin tests, offered through the (online) education in
17 11 the REVERT study, was the most important facilitator for reducing vitamin testing according to the
18 12 GPs. GPs mentioned that, apart from the up-to-date knowledge, the concrete patient examples and
19 13 the background information about guideline-based indications for vitamin testing and treatment
20 14 discussed in the (online) education in the REVERT study also contributed to changing testing
21 15 behaviour regarding vitamin D and B12, because it was helpful in giving explanations to patients about
22 16 the usefulness of vitamin testing.
23 17

24 18 Lack of repetition of the information was mentioned as the most important cognitive barrier to
25 19 remembering, with the risk of falling back into old patterns of test ordering. Four GPs mentioned that it
26 20 was difficult to remember all the information received during the single moment of (online) education.
27 21 Nine GPs mentioned that it was easier to remember all the information if they had received other
28 22 education about this subject in the past or frequently discussed the topic in meetings with colleagues.
29 23

36 24 ***Conflicting medical information***

37 25 Conflicting results and recommendations from other information sources were mentioned as the most
38 26 important barrier to reducing the number of vitamin tests requested by GPs. About half of the GPs
39 27 mentioned these conflicting results in the literature about the association between symptoms and
40 28 vitamin levels as a problem in building up their argumentation during the patient consultation. They
41 29 also mentioned that global recommendations, sometimes differ from national guideline
42 30 recommendations. These inter-country differences were mentioned as a reason for discussion with
43 31 patients. Some GPs therefore thought it difficult to resist vitamin test requests from patients, especially
44 32 when patients' "knowledge" seemed to be better than their own knowledge on this topic.
45 33

50 34 *(GP5, woman, 37 years) 'GP does not feel confident enough about knowledge'*

51 35 *"It is still very difficult to translate the information that you received from (online) education to an*
52 36 *explanation for a very demanding patient in 10 minutes. Especially when the patient has searched for*
53 37 *a lot of different articles that emphasise the importance of vitamin testing.”*
54 38

55 39 As part of a sustainable strategy to reduce vitamin testing in general practice, GPs mentioned the
56 40 need for an overview of up-to-date knowledge about vitamin testing in a national guideline or protocol.
57
58
59
60

1
2
3 1 GPs thought that such a protocol would make it easier for health professionals to quickly search for
4 2 answers when unable to recall the information from previous (online) education.
5
6 3

7 4 *(GP4, woman, 38 years) 'Need for a protocol'*

8
9 5 "So, I needed some kind of protocol that included the 10 most important things that I had learnt during
10 6 the online education. I noticed that I had difficulty recalling information from previous sessions and
11 7 therefore returned."
12
13 8

9 **Social factors affecting GPs' testing behaviour**

10 GPs reported the following social factors affecting their testing-behaviour: (1) interaction with patients,
11 (2) attitudes of other health professionals, and (3) influence of media and society.
12

13 ***Interaction with patients***

14 GPs indicated that good communication skills are needed to provide explanations and to convince
15 patients that vitamin tests are not always necessary. GPs also mentioned that a low education level
16 and language barriers made it more difficult to communicate and that they regarded these as barriers
17 to providing a good explanation to patients on the limited usefulness of vitamin testing.
18

19 GPs mentioned that it was easier to convince patients with whom they had a long relationship
20 compared to patients who were relatively new in their general practice. One GP mentioned using her
21 seniority, due to her age, making it easier to convince patients to agree with non-testing.
22

23 ***Attitudes of other health professionals***

24 Six GPs mentioned that their partner GPs in the practice were less motivated to reduce unnecessary
25 vitamin tests or had different opinions about vitamin testing than themselves. Also, the presence of
26 locum doctors in the practice was mentioned as a barrier to reducing the number of vitamin tests
27 requested, because locums were found to request vitamin tests more often. In some practices,
28 assistants were able to request vitamin levels on their own initiative, limiting the reduction in vitamin
29 testing. On the other hand, four GPs reported that all the GPs in their practice had the same thoughts
30 and restrictive methods regarding vitamin testing. Furthermore, it was considered helpful if other
31 health professionals, e.g. GPs' assistants, had up-to-date knowledge about vitamin testing through
32 education in order to provide patients with the same message on the limited usefulness of vitamin
33 testing.
34

35 *(GP19, man, 35 years) 'Up-to-date knowledge among GPs' assistants*

36 "It is important that the assistants have the same knowledge as the GPs, because they are asked the
37 most questions about vitamin testing."
38

39 ***Influence of media and society***

59
60

1
2
3 1 Another reported factor that made it difficult to reduce vitamin tests is the information spread about the
4 2 suggested importance of unrestricted vitamin D and B12 tests by other healthcare professionals, the
5 3 social media, or other patients. In line with this, GPs suggested that more support from colleagues,
6 4 media, and society should be part of a sustainable strategy to reduce unnecessary vitamin tests. GPs
7 5 specifically mentioned the need for reliable information resources for patients.
8
9
10
11

12 7 **Patients' motivational factors**

13 8 Two components of patients' motivation to change behaviour could be distinguished: (1) attitudes
14 9 towards GPs and (2) attitudes towards vitamin testing.
15
16
17

18 11 **Attitudes towards GPs**

19 12 About half of the patients mentioned that they had a negative attitude on this subject towards their GP.
20 13 These patients were convinced that their GP did not have enough knowledge about vitamins (tests);
21 14 this resulted in distrust and dissatisfaction with the information provided and the decisions made by
22 15 their GP regarding vitamin testing.
23
24
25

26 17 *(P12, woman, 40 years) 'GP does not have enough knowledge'*

27 18 *"I decided to look up all the information I wanted to know, because my GP couldn't tell me much about*
28 19 *it, that was a pity. I think that I do know more about vitamin testing than my GP knows."*
29
30
31

32 21 **Attitudes towards vitamin testing**

33 22 Most of the patients also had a negative attitude towards a policy of 'not testing' and even suggested
34 23 that it would be better if GPs increased vitamin testing and paid more attention to vitamin deficiencies.
35 24 In line with a negative attitude towards 'not testing', about 50% of the patients reported not seeing any
36 25 alternative for vitamin blood tests. Moreover, they stated their dissatisfaction with GPs who were
37 26 unwilling to test their vitamin levels. Two patients mentioned that they would keep asking their GP for
38 27 vitamin tests until their request was met.
39
40
41
42

43 28
44 29 *(P5, woman, 53 years) 'Keep asking the GP for vitamin testing'*

45 30 *"The GP always disagrees with my requests for vitamin testing, saying: 'I don't think that vitamin*
46 31 *deficiency is the problem'. I have to be very demanding and in the end I get what I want."*
47
48
49

50 33 Some patients mentioned that they would accept a satisfactory explanation from their GP about the
51 34 reasons for not testing if the GP disagreed with their vitamin test request. Two patients suggested that
52 35 health professionals with a background in alternative medicine could be consulted as an alternative for
53 36 having vitamin levels in their blood tested when the GP disagreed with their request.
54
55
56

57 38 **Patients' cognitive factors**

58
59
60

1
2
3 1 Two components of cognition and knowledge about vitamin (testing) can be identified in patients: (1)
4 2 thoughts and attitudes regarding information sources and (2) patients' reasons for wanting to be
5 3 tested.
6 4

5 **Thoughts and attitudes regarding information sources**

6 Most of the patients used the internet to search for information about vitamins. Five patients had read
7 information about vitamins in books and magazines. Psychological symptoms, myalgia, and fatigue
8 were the most frequently mentioned symptoms associated with vitamin D and B12 deficiencies.
9 Patients mentioned that the information that they found on the association between vitamin
10 deficiencies and symptoms gave them an explanation for their symptoms.
11

12 *(P17, woman 31 years) 'Online information sources'*

13 *"I decided to look online for more information and I recognised a lot of my symptoms in the stories that*
14 *I read on the internet."*
15

16 Patients thought it confusing that there are differences between reference levels and advices between
17 countries and study results. They mentioned that these differences made it more difficult to believe
18 that their GP's reference levels were correct.
19

20 **Patients' reasons for wanting to be tested**

21 Patients' main reason for asking their GP to have their vitamin levels tested was fatigue. Other
22 reasons mentioned were depressive symptoms, weight loss, and myalgia. A vegetarian or vegan diet
23 was also mentioned as a reason for having a vitamin B12 test. Some patients mentioned that a history
24 of vitamin deficiency strengthened their request to have their vitamin D and/or B12 levels tested.
25
26

27 **Discussion**

29 **Summary of key findings**

30 In this qualitative analysis, we found a wide spectrum of patient- and GP-related perceptions and
31 attitudes that affect vitamin test ordering in clinical practice (summarised in Figure 1). The most
32 important factors hampering vitamin test reduction programmes are the mismatch between patients
33 and medical professionals regarding the presumed indications for testing for vitamin D and B12,
34 differences in motivation, and the GPs' tendency to avoid conflict. The most important facilitator for
35 vitamin test reduction programmes is updating GPs' knowledge about test indications in combination
36 with improving their awareness of their individual test behaviour.
37

38 *Reasons for testing differed between patients and GPs.*

39 For patients, the most important reasons to ask for vitamin testing were (non-specific) medical
40 symptoms based on information found on the internet and confirmed by other media, contacts, and

1
2
3 1 sometimes other healthcare professionals. GPs, however, mentioned being aware of the lack of
4 2 indication for vitamin testing when patients presented with non-specific medical symptoms.
5
6 3

7 4 GPs used information from the (online) project education to rebut patients' ideas and explain about the
8 5 limited usefulness of vitamin testing. Conflicting results and recommendations between different
9 6 information sources result in confusion about indications and the usefulness of vitamin testing among
10 7 both GPs and patients, creating discussion between GP and patients. A difference between patients
11 8 and GPs in their motivation to change testing behaviour was also identified. Whereas most GPs were
12 9 very motivated to reduce vitamin testing, most patients suggested that it would be better if GPs tested
13 10 more frequently for vitamin deficiencies in general practice.
14
15
16
17 11

18
19 12 Another barrier to reducing the number of vitamin tests was GPs' tendency to avoid conflict and satisfy
20 13 patients in order to foster good relationships with patients. In line with this, good communication skills
21 14 facilitated GPs in discussing and explaining the limited usefulness of vitamin testing to patients.
22
23 15

24 16 Other facilitators for reducing the number of vitamin tests according to GPs were consensus between
25 17 healthcare professionals and ongoing feedback on testing behaviour, but almost all GPs mentioned
26 18 up-to-date knowledge about the usefulness of vitamin testing through education as the most important
27 19 facilitator for reducing vitamin tests.
28
29
30 20

31 21 Following from this, to enable GPs to recall information, a reliable overview of the evidence and
32 22 recommendations regarding vitamin testing is warranted. GPs mentioned that this knowledge should
33 23 also be available to other healthcare professionals and patients in order to create unanimity about the
34 24 usefulness of vitamin tests. GPs also suggested getting regular individual feedback about their testing
35 25 behaviour to keep them motivated to test only when necessary and to have a tool to remind them to
36 26 change their testing behaviour.
37
38
39 27

40 28 **Results in context**

41
42 29 Patients and GPs having conflicting information was one of the main barriers to reducing unnecessary
43 30 vitamin testing. In line with our results, previous research has highlighted that not only health
44 31 professionals, but also the media, are key information providers on this topic for patients.²⁰ A media
45 32 content analysis showed that news articles linked vitamin D to a wide range of health conditions
46 33 without conclusive scientific evidence.²¹ As reflected by our study as well as previous research, this
47 34 has resulted in confusion regarding the usefulness of vitamin testing, among both patients and GPs.⁹
48 35 ²² Moreover, GPs' information sources also present conflicting results, reinforcing this confusion. To
49 36 counter this, previous research highlighted the need for clear information that reflects the actual state
50 37 of knowledge and for ongoing research for both healthcare professionals and patients.^{9, 10, 20} Similarly,
51 38 GPs in this study mentioned that clear guidelines for patients and GPs regarding vitamin testing would
52 39 help them in discussions with their patients. In line with this, in this study education was found as one
53 40 the most important facilitators for reducing vitamin testing. Previous research showed that education
54
55
56
57
58
59
60

1
2
3 1 and communication through electronic educational codified comments might improve vitamin
4 2 requests.²³ In addition, strategies for reducing unnecessary vitamin testing require continuous
5 3 education, because the intervention-effect of education seems to decrease over time.²⁴
6 4

7 4
8 5 Feedback on testing behaviour was found to be another important facilitator for reducing the number
9 6 of unnecessary vitamin tests. This is in line with an RCT that showed that feedback of requesting rates
10 7 was an effective strategy for reducing laboratory testing in primary care.²⁵ The results of a systematic
11 8 review suggest that feedback may be more effective when it is provided more than once and when it
12 9 includes both measurable targets and an action plan.²⁶ These suggestions could be useful for
13 10 implementing feedback on testing behaviour in the future. GPs suggested that feedback on individual
14 11 GP behaviour might be more effective than feedback on practice level. Such individual feedback might
15 12 contribute to the measurability of targets and a personalised action plan.
16 13

14 **Strengths and limitations**

15 15 This is the first study to use semi-structured interviews to explore the barriers and facilitators for
16 16 reducing the number of (unnecessary) vitamin D and B12 laboratory tests ordered. The qualitative
17 17 approach and the use of open-coding based on a broad theoretical framework allowed us to highlight
18 18 all the different aspects behind the complexity of reducing vitamin testing. The validity and reliability of
19 19 this study were strengthened by including patients from a broad range of backgrounds, as well as GPs
20 20 from 20 different practices.
21 21

22 22 Still, a few limitations need to be addressed. First, participating GPs were affiliated to a research
23 23 network and therefore might not have been representative of all GPs in the Netherlands. Next, patients
24 24 were invited for the interviews by their GPs; this creates a potential bias arising from the selection of,
25 25 for example, more outspoken patients. However, patient characteristics (Table 1) show large variation
26 26 in age, sex, and educational level, making inclusion of different patient perspectives likely. Finally,
27 27 even though the same interview guide was used, the interviews in this study were performed by two
28 28 different researchers, who may have had differences in their interviewing style that may have
29 29 influenced participants' responses.
30 30

31 **Recommendations**

32 32 From a GP's perspective, a sustainable reduction in vitamin test requests in primary care requires the
33 33 following steps: (1) updating GPs' knowledge through (online) education, (2) guidelines with clear and
34 34 uniform recommendations on prevailing indications for vitamin testing and supplementation for all
35 35 healthcare professionals, and (3) regular (individual) feedback on GPs' test behaviour.
36 36

37 37 From a societal perspective, access to clear and reliable information on vitamin testing for the
38 38 population is needed, from trustful sources. In addition, the spread of non-evidence-based information
39 39 through lay media should be challenged. Further research is required to measure the effect of these
40 40 strategies on reducing vitamin testing.

Conclusion

In conclusion, conflicting information about the usefulness of vitamin testing, differences in motivation between patients and GPs, as well as GPs' tendency to avoid conflict and to satisfy patients are important barriers to reducing the number of vitamin tests. Nevertheless, updating GPs' knowledge, feedback on GPs' testing behaviour, and guidelines with clear recommendations for all healthcare professionals (including patient information) on prevailing indications for vitamin testing and supplementation could facilitate a sustainable reduction in vitamin testing in primary care.

Acknowledgements

We would like to thank the entire REVERT team for their diligence, expertise and enthusiasm. Finally, we are indebted to all patients and GPs who consented to be interviewed, without whom this study would not have been possible.

Figure 1. Patient- and GP-related perceptions and attitudes affecting vitamin test ordering in clinical practice

1 References

- 1 Sattar N, Welsh P, Panarelli M, et al. Increasing requests for vitamin D measurement: costly, confusing, and without credibility. *The Lancet* 2012;379:95–6.
- 2 Franken P, Geutjes P, van den Ouweland J, et al. Diagnose van vitamine-B12-tekort. *Huisarts en wetenschap* 2015;58:530–1.
- 3 Medicare Payments for Clinical Diagnostic Laboratory Tests in 2016: Year 3 of Baseline Data 2017. <https://oig.hhs.gov/oei/reports/oei-09-17-00140.asp>.
- 4 Bilinski K, Boyages S. Evidence of overtesting for vitamin D in Australia: an analysis of 4.5 years of Medicare Benefits Schedule (MBS) data. *BMJ Open* 2013;3:e002955. doi: 10.1136/bmjopen-2013-002955
- 5 LeFevre ML, LeFevre NM. Vitamin D Screening and Supplementation in Community-Dwelling Adults: Common Questions and Answers. *Am Fam Physician* 2018;97(4):254-60.
- 6 Bindels PJ. Vitamin D: what to do with it? *Ned Tijdschr Geneesk* 2015;159:A8837.
- 7 Langan RC, Goodbred AJ. Vitamin B 12 Deficiency: Recognition and Management. *Am Fam Physician* 2017;96:384–89.
- 8 Moynihan R, Doust J, Henry D. Preventing overdiagnosis: how to stop harming the healthy. *BMJ: British Medical Journal (Online)* 2012;344:e3502. doi: 10.1136/bmj.e3502.
- 9 Kotta S, Gadhvi D, Jakeways N, et al. "Test me and treat me"-attitudes to vitamin D deficiency and supplementation: a qualitative study. *BMJ Open* 2015;5: e007401. doi:10.1136/bmjopen-2014-007401
- 10 Gowda U, Smith BJ, Wluka AE, et al. Vitamin D testing patterns among general practitioners in a major Victorian primary health care service. *Aust N Z J Public Health* 2016;40:144–7.
- 11 Rodriguez-Borja E, Corchon-Peyrallo A, Barba-Serrano E, et al. "Send & hold" clinical decision support rules improvement to reduce unnecessary testing of vitamins A, E, K, B1, B2, B3, B6 and C. *Clinical Chemistry and Laboratory Medicine (CCLM)* 2018;56:1063-70.
- 12 Michiels-Corsten M, Donner-Banzhoff N. Beyond accuracy: hidden motives in diagnostic testing. *Fam Pract* 2018;35;222–7.
- 13 Haijaj FM, Salek MS, Basra MK, et al. Non-clinical influences on clinical decision-making: a major challenge to evidence-based practice. *J R Soc Med* 2010;103:178-87.

- 1
2
3 14 O'Brien BC, Harris IB, Beckman TJ, et al. Standards for reporting qualitative research: a synthesis
4 of recommendations. *Acad Med* 2014;89:1245-51. doi:10.1097/ACM.0000000000000388.
5
6
7 15 Charmaz K. *Constructing grounded theory: A practical guide through qualitative analysis*. Sage
8 2006.
9
10
11 16 Grol R, Wensing M, Bosch M, et al. Theories on implementation of change in healthcare. *Improving*
12 *Patient Care: The Implementation of Change in Health Care, Second Edition* 2013:18–39.
13
14
15 17 Social and Cultural office [Sociaal en Cultureel Planbureau], Social economic factors
16 [Statusscores]. 2009.
17
18
19 18 Guest G, Bunce A, Johnson L. How many interviews are enough? An experiment with data
20 saturation and variability. *Field Methods* 2006;18:59–82.
21
22
23 19 Zamawe FC. The implication of using NVivo software in qualitative data analysis: Evidence-based
24 reflections. *Malawi Medical Journal* 2015;27:13–15.
25
26
27 20 Deschasaux M, Souberbielle J, Partula V, et al. What do people know and believe about vitamin
28 D?. *Nutrients* 2016;8:718.
29
30
31 21 Caulfield T, Clark MI, McCormack JP, et al. Representations of the health value of vitamin D
32 supplementation in newspapers: media content analysis. *BMJ Open* 2014;4: e006395. doi:10.1136/
33 bmjopen-2014-006395.
34
35
36 22 Bennett K, Frisby BN, Young LE, et al. Vitamin D: an examination of physician and patient
37 management of health and uncertainty. *Qual Health Res* 2014;24:375–86.
38
39
40 23 Salinas M, López-Garrigós M, Flores E, et al. Education and communication is the key for the
41 successful management of vitamin D test requesting. *Biochemia medica: Biochemia medica*
42 2015;25:237-41.
43
44
45 24 Miyakis S, Karamanof G, Lontos M, et al. Factors contributing to inappropriate ordering of tests in
46 an academic medical department and the effect of an educational feedback strategy. *Postgrad Med J*
47 2006;82:823-9 doi:82/974/823.
48
49
50 25 Thomas RE, Croal BL, Ramsay C, et al. Effect of enhanced feedback and brief educational
51 reminder messages on laboratory test requesting in primary care: a cluster randomised trial. *The*
52 *Lancet* 2006;367:1990–6.
53
54
55 26 Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: effects on professional practice and
56 healthcare outcomes. *Cochrane Database of Systematic Reviews* 2012. Issue 6. Art. No.: CD000259.
57
58
59 DOI: 10.1002/14651858.CD000259.pub3.
60

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

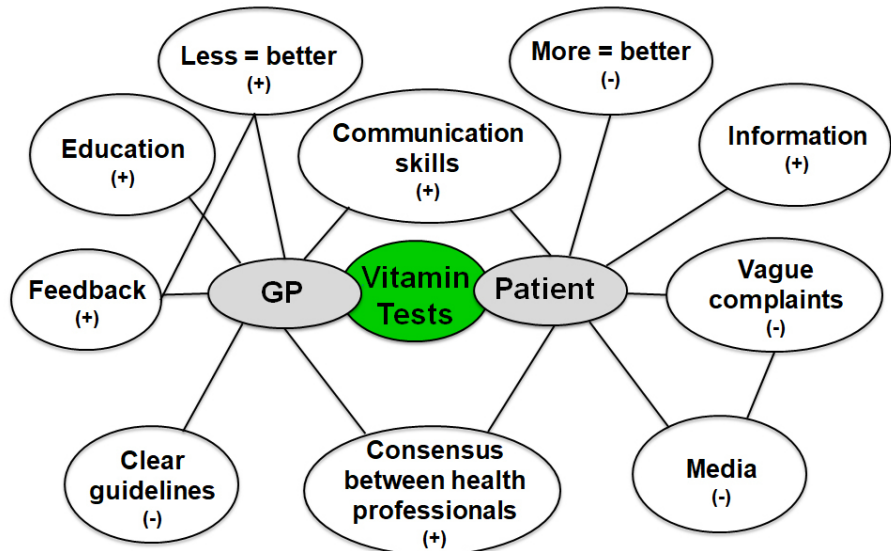


Figure 1. Patient- and GP-related perceptions and attitudes affecting vitamin test ordering in clinical practice.

90x60mm (300 x 300 DPI)

Reporting checklist for qualitative study.

Based on the SRQR guidelines.

		Reporting Item	Page Number
	#1	Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g. ethnography, grounded theory) or data collection methods (e.g. interview, focus group) is recommended	4
	#2	Summary of the key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results and conclusions	2
Problem formulation	#3	Description and significance of the problem / phenomenon studied: review of relevant theory and empirical work; problem statement	3, 4
Purpose or research question	#4	Purpose of the study and specific objectives or questions	4
Qualitative approach and research paradigm	#5	Qualitative approach (e.g. ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g. postpositivist, constructivist /	4, 5, 6

interpretivist) is also recommended; rationale. The rationale should briefly discuss the justification for choosing that theory, approach, method or technique rather than other options available; the assumptions and limitations implicit in those choices and how those choices influence study conclusions and transferability. As appropriate the rationale for several items might be discussed together.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35	Researcher characteristics and reflexivity	#6	Researchers' characteristics that may influence the research, including personal attributes, qualifications / experience, relationship with participants, assumptions and / or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results and / or transferability	5
36 37 38	Context	#7	Setting / site and salient contextual factors; rationale	4, 5
39 40 41 42 43 44 45 46 47 48	Sampling strategy	#8	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g. sampling saturation); rationale	5, 6
49 50 51 52 53 54 55 56 57 58 59 60	Ethical issues pertaining to human subjects	#9	Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues	3

1	Data collection methods	#10	Types of data collected; details of data collection	5, 6
2				
3			procedures including (as appropriate) start and stop	
4			dates of data collection and analysis, iterative process,	
5			triangulation of sources / methods, and modification of	
6			procedures in response to evolving study findings;	
7			rationale	
8				
9				
10				
11				
12				
13				
14				
15	Data collection	#11	Description of instruments (e.g. interview guides,	5, 6
16				
17	instruments and		questionnaires) and devices (e.g. audio recorders) used	
18			for data collection; if / how the instruments(s) changed	
19	technologies		over the course of the study	
20				
21				
22				
23				
24				
25	Units of study	#12	Number and relevant characteristics of participants,	5, 6
26				
27			documents, or events included in the study; level of	
28			participation (could be reported in results)	
29				
30				
31				
32				
33	Data processing	#13	Methods for processing data prior to and during	5, 6
34				
35			analysis, including transcription, data entry, data	
36			management and security, verification of data integrity,	
37			data coding, and anonymisation / deidentification of	
38			excerpts	
39				
40				
41				
42				
43				
44				
45	Data analysis	#14	Process by which inferences, themes, etc. were	6
46				
47			identified and developed, including the researchers	
48			involved in data analysis; usually references a specific	
49			paradigm or approach; rationale	
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

1	Techniques to enhance	#15	Techniques to enhance trustworthiness and credibility	5, 6
2				
3	trustworthiness		of data analysis (e.g. member checking, audit trail,	
4			triangulation); rationale	
5				
6				
7				
8	Syntheses and	#16	Main findings (e.g. interpretations, inferences, and	6-13
9			themes); might include development of a theory or	
10	interpretation		model, or integration with prior research or theory	
11				
12				
13				
14				
15				
16	Links to empirical data	#17	Evidence (e.g. quotes, field notes, text excerpts,	8-13
17			photographs) to substantiate analytic findings	
18				
19				
20				
21				
22	Intergration with prior	#18	Short summary of main findings; explanation of how	13-16
23			findings and conclusions connect to, support, elaborate	
24	work, implications,		on, or challenge conclusions of earlier scholarship;	
25			discussion of scope of application / generalizability;	
26	transferability and		identification of unique contributions(s) to scholarship in	
27			a discipline or field	
28	contribution(s) to the			
29	field			
30				
31				
32				
33				
34				
35				
36	Limitations	#19	Trustworthiness and limitations of findings	15
37				
38				
39	Conflicts of interest	#20	Potential sources of influence of perceived influence on	1
40			study conduct and conclusions; how these were	
41			managed	
42				
43				
44				
45				
46				
47	Funding	#21	Sources of funding and other support; role of funders in	1
48			data collection, interpretation and reporting	
49				
50				
51				

The SRQR checklist is distributed with permission of Wolters Kluwer © 2014 by the Association of American Medical Colleges. This checklist was completed on 02. February 2019 using

1 <https://www.goodreports.org/>, a tool made by the [EQUATOR Network](#) in collaboration with

2
3 [Penelope.ai](#)
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only