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Evidence-based website reduces health care utilization: a nationwide natural experiment

Short title: website use and health care utilization

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Abstract

Objectives – Health care costs and utilization are rising. Evidence-based online health information may reduce health care utilization, but the evidence is scarce. The objective of this study was to determine whether the release of a nationwide evidence-based health website was associated with a reduction in health care utilization.

Design – Interrupted time series analysis of observational primary care data of health care use in the Netherlands from 2009 to 2014.

Setting – General community primary care.

Population – 912 000 patients who visited their general practitioners 18.1 million times during the study period.

Intervention – In march 2012, an evidence-based health information website was launched by the Dutch College of General Practitioners. It was easily accessible and understandable using plain language. At the end of the study period, the website had 2.9 million unique page views per month.

Main outcomes measures – Primary outcome was the change in consultation rate (consultations/1000 patients/month) before and after the release of the website. Additionally, a reference group was created by including consultations about topics not being viewed at the website. Subgroup analyses were performed for type of consultations, sex, age and socioeconomic status.

Results – After launch of the website, the trend in consultation rate decreased with 1.620 consultations/1000 patients/month (p<.001). This corresponds to a 12% decline in consultations two years after launch of the website. The trend in

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consultation rate of the reference group showed no change. The subgroup analyses showed a specific decline for consultations by phone and was significant for all other subgroups, except for the youngest age group.

Conclusions – Health care utilization decreased with 12% after providing high quality evidence-based online health information. These findings show that e-health can be effective to improve self-management and reduce health care utilization in times of increasing health care costs.

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Article summary

Strengths and limitations of this study

- Long-term follow-up (6 years) in large number of health care consultations (18.1 million)
- An interrupted time series analysis is the strongest research design when randomisation is not possible
- A change in trend of the outcome before and after the intervention and additional use of a reference group supports a causal effect of the intervention
- Actual health care utilization rates based on registries were used, instead of self-reported health care use
- Other events might have affected health care utilization during our study period, but were carefully considered and analysed

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Introduction

Health care costs and utilization are rising in western countries and projected to increase even faster due to the ageing population.[1-3] Health care workers and policy makers are seeking ways to control health care costs and utilization while simultaneously improving health care quality. An important reason for patients to use health care is the need for information.[4] Many patients seek online for health information and use this information to decide whether or not to visit a doctor.[5, 6] So, in theory, patients using online health information are well-informed and make a better assessment on the need to visit a doctor, leading to lower utilization of health care. However, online health information is of inconsistent quality[7] and evidence for the effects on health care utilization is scarce. Previous studies showed heterogeneous results: online information did not change or even increased health care utilization in some studies.[8-17] An important limitation of these studies is that most estimated health care utilization by patient self-reporting instead of actual health care utilization statistics. Furthermore, the effects of online health information might be different in subgroups of sex, socioeconomic status (SES) and age. Online health information seekers are mostly young women with a high SES.[5, 18-21] A recent study, investigating the effect of an online support programme on health care utilization in infants, found no difference in this youngest-age subgroup.[16, 22]

The Dutch College of General Practitioners (NHG) launched a non-commercial evidence based, public website in the Netherlands in march 2012.[23] The NHG is the Dutch scientific society of general practitioners (GPs), and publishes and updates nationally implemented evidence-based guidelines.[24] The content on the website is

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based on those guidelines. The primary goal of the website was to provide reliable and understandable medical information.[23] Since its launch, the website has grown to become one of the most visited health care website in the Netherlands. However, its effect on health care utilization is not yet known. We therefore conducted a nationwide study to test the hypothesis that providing evidence-based online health information is associated with a reduction of health care utilization. Secondly, we investigated whether the effect on health care utilization was modified by sex, age and SES.

Methods

Design and participants

We used a natural before-after quasi-experimental design to study the number of consultations in primary care before and after the launch of the website (www.thuisarts.nl) in march 2012. Observational data were used from NIVEL Primary Care Database (http://www.nivel.nl/en/dossier/nivel-primary-care-database) from 2009 to 2014. This time period provides data points from three years before and nearly three years after the website launch, giving enough data points to evaluate changes in trends.[25, 26] To ensure data quality, only GPs were included who recorded more than 70% of their consultations with ICPC codes and provided data for the entire calendar year. Nationally representative data[27] of on average 230 general practitioners were sampled in each year, representing 911 177 inhabitants (5.4% of the total Dutch population). GP patient contacts and diagnoses are coded according to the ICPC-1 (International Classification of Primary Care)[28]. Data were

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anonymized, but contained records for sex, age and zip codes for each patient. Dutch law allows the use of electronic health records for research purposes under certain conditions. According to this legislation, neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of observational studies containing no directly identifiable data (Dutch Civil Law, Article 7:458).

Data sharing

Technical appendix, statistical code, and dataset available from the last author (NHC).

Intervention

The website (www.thuisarts.nl) was launched in march 2012 by the Dutch minister of health, welfare and sports. Since then it is a publicly available non-commercial website, providing reliable medical information and advice.[23] Because all information and advice is based on the guidelines of the NHG, the online advice matches the most recent GPs' advice.[24] The online content is evidence-based, uses plain understandable language and covers over 600 topics. Furthermore, the website contains videos, interactive anatomical features, decision aids and is being kept up-to-date by a team of professionals.[23] The popularity of the website has grown exponentially, having currently 3 million unique page views each month.

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Outcomes

The primary outcome was defined as the trend in total number of consultations per 1000 patients per month before and after launch of the website. The total number of consultations was calculated in each month and divided by the number of quarterly enlisted patients, multiplied by 1000. Since the outcome was expected to have a seasonal fluctuation, a monthly interval was chosen. The secondary outcome was the trend in consultation rate for a selection of top 10 popular topics on the website. A top 10 of the topic pages was created before starting the analyses and was based on the number of unique page views, which were extracted using google analytics. A unique page view was defined as the number of times a page was loaded by a visitor's browser. If a visitor viewed a page several times during a single session, it only counted as one page view. The following topics (ICPC codes) were selected using this criterion before conducting the analyses: herpes zoster (S70), lower back pain (L02 and L03), bladder infection in women (U71), vaginal discharge (X14), shoulder complaints (L08 and L92), gout (T92), constipation (D12), irritable bowel syndrome (D93), diarrhoea (D11, D70 and D73) and sinusitis (R75).

The primary analysis consists of a comparison of health care use before and after the launch of the website. So, the most important control period was the period before release of the website. However, because changes in the health care system could have affected health care utilization after release of the website, we additionally incorporated a reference group with health topics that were not exposed to the intervention. These topics were selected before conducting the analyses and included when no online information was available or page views of the topic very

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low on the website during the study period. These topics were head trauma (N79 and N80), premenstrual syndrome (X09) and contact eczema (S88).

Subgroup and sensitivity analyses

Pre-specified subgroup analyses were performed for different type of consultations: short consultations (20 minutes or less), long consultations (more than 20 minutes) and consultations by phone. Furthermore, subgroups of sex, SES and age were analysed. SES groups were created based on the available zip codes and using data of the Netherlands Institute for Social Research.[29] Furthermore, four sensitivity analyses were performed. First, because website page views increased exponentially, the relative and absolute level change one and two years after the intervention was calculated. In the second sensitivity analysis we included only the GPs recording >95% of their consultations under an ICPC code, because an improvement in recording over time could have affected the consultation rate of the secondary outcome. GPs participating the entire study period were included in the third sensitivity analysis. Fourth, due to changes in insurance policies, consultations performed for chronic care (asthma, COPD, diabetes and cardiovascular risk management) by nurse practitioners fluctuated during the study period. To exclude any influence of these fluctuations, we performed the primary analyses separately for chronic- and non-chronic care consultations.

Statistical analysis

To evaluate the longitudinal impact of the introduction of the website, an interrupted

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time series (ITS) analysis was used. ITS is considered a strong design when randomisation is not possible and can thus be used to study causal effects using an observational 'natural experiment' approach.[30] ITS measures the change in outcome, taking pre-existing trends in the data into account, thereby negating the effect of other factors influencing the outcome, provided that those factors remain constant.[25, 26] So, the primary outcome's most important control period was the trend in consultation rate before release of the website. To additionally control for factors that did not remain constant after the release of the website, a reference group was created for consultations not exposed to the intervention.[30]

The Cochrane Collaboration guideline on ITS analyses was used, applying an autoregressive integrated moving average (ARIMA) model.[25] For the primary and secondary outcomes, the trends in consultation rate before and after the launch of the website in march 2012 were compared by calculating the slope change. Level changes at 12 and 24 months were estimated by forecasting the pre-intervention model and comparing this with the post-intervention model. The time series reached stationarity after differencing once, indicating linearity in our model. Since slope changes were our outcome of interest, an undifferenced time series was used for the ITS analysis. We evaluated auto-correlation and seasonality by inspecting the autocorrelation (ACF) and partial autocorrelation functions (PACF), finding autocorrelations at lag 1 and 12. Hence, an ARIMA 1(1,0,0) model and seasonal ARIMA 12(1,0,0) model was fitted. After applying the model the ACF and PACF of the noise residuals were inspected and tested by using the Box-Ljung statistic, finding no relevant residual autocorrelations, which confirmed adequacy of the model.[25, 26] All analyses were performed in SPSS version 20.0 (IBM Corporation,

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New York, USA). Values were considered to be statistically significant at a p-value <.05.

Results

The total number of consultations during the 6-year study period was 18.1 million, with a mean (SD) of 290 (21) per 1000 patients in each month. The mean (SD) age of the study population was 40 (23) years with 51% females. The total amount of unique page views of the website during the study period was 56.6 million, with a monthly mean of 450 000 in 2012 and increased to 2.9 million per month in the end of 2014 (figure 1). Trends of total number of consultations before and after the launch of the website are depicted in figure 1. Before the launch of the website, the consultation rate increased with 0.826/1000/month. However, after the launch of the website, this rate decreased to -0.794/1000/month, giving a slope change of -1.620 (p<.001; table 1). The slope for all consultation types declined (figure 2), but only the decline for telephone consultations significantly, with a slope change of -1.056 (p=.001; eTable 1).Trends for the secondary outcome are depicted in figure 3. The consultations for top 10 topics decreased (slope change: -0.169; p=.003; table 1), while the consultation rate for the reference group did not change (slope change: -0.001; p=.96; table 1). When analysed separately, the consultation rate decreased significantly for six of the top 10 topics. The consultation rate did not change significantly for any of the 3 reference topics (table 1).

Subgroup and sensitivity analyses

For all subgroups of sex, age and SES, the stratified analyses showed a significant

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decrease in consultation rate (table 2), except the youngest age group (0-16 years). In the first sensitivity analysis, calculating level changes one and two years after launch of the website, the consultation rate had decreased with 6.2% after one year and with 11.6% after two years (eTable 2). In our study population, this corresponds with a reduction of 62 300 consultations in the month march 2014. The second sensitivity analysis, including only high-grade recording GPs and the third sensitivity analysis, including only GPs recording throughout the entire study period, confirmed the results of the main analysis (eTable 3 and 4). In the fourth sensitivity analysis, a similar decrease in consultation rate was found for chronic- and non-chronic care consultations (eTable 5).

Discussion

In this nationwide natural experiment, health care utilization in primary care decreased after the launch of an evidence-based health information website. This strongly suggests that, by providing evidence based online health information, health care utilization can be affected: in our study, consultation numbers decreased with almost 12% after two years. When extrapolated to the entire Dutch population, this translates to a reduction of 675 000 consultations in the month march 2014 only, exactly two years after the intervention. Interestingly, the decline was most distinct for the consultations by phone. Those consultations usually encompass non-essential care, and are therefore most likely to be affected by providing online information.[31] Importantly, health care use in the period before release of the website was not declining, and even rising. In addition, a reference group was used to detect

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effects of other factors influencing consultation rates which were not accounted for by the pre-intervention trend. After release of the website, this reference group showed no change at all, which supports a causal relation between the launch of the website and the reduction of health care utilization. The reduction was robustly present in all the subgroups, except in the youngest age group.

Strengths and limitations

The major strengths of this study are its before-after design and additional use of a reference group. The rise of consultation rates before release of the website, the decline after release of the website and the absence of change in consultation rate in the reference group supports a causal relation between the intervention and the observed effects. A limitation is that, due to nationwide implementation of the website, no reference group could be created which was not exposed to the website at all during the study period. As an alternative, we selected topics which were not on the website (head trauma) or had very low page views during the study period (premenstrual syndrome and contact eczema). They consider health topics for which self-management with online information is feasible and in our opinion thus form a valid reference group. Although the absolute number of consultations for these reference topics were substantially lower than the top 10 topics, they provide insight in the stability of health care utilization without exposure to the website. Another strength is that we investigated the impact of this e-health intervention using actual health care utilization rates, instead of questionnaire based estimates. Importantly, our data is representative of the Dutch population.[27] Another strength is the long-term study duration of 6 years, providing enough data points to account for

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seasonality and pre-intervention trends. Although ITS is considered the strongest research design when randomisation is not possible and can in theory be used to study causal effects using observational data,[30] we carefully considered other events that might have affected health care utilization during our study period. For example, one of the main incentives for health care utilization are reimbursements. During our study period, a stepwise increase of the deductible to €360 in 2014 occurred. However, primary care consultations were always fully covered by the health insurance, while secondary care consultations were not. In addition a stable 3% of the Dutch population avoids primary care due to financial reasons[32], which cannot explain the decrease in consultation rate of 12%. Another factor possibly influencing primary care consultation rate is fluctuations of chronic care consultations performed by nurse practitioners. We addressed this by stratifying our analysis for chronic- and non-chronic care consultations and found a similar decline of consultation rate for both. Furthermore, we considered a change over time of the general practice characteristics as a confounding variable for the primary outcome and a change in registration grade as a confounding variable for the secondary outcome. After including only general practitioners which participated throughout the entire study period and after including only high-grade recording general practitioners, a similar decline in trend was found as in the main analysis. Although the website reached 3 million page views by the end of 2014, the reduction in health care use did not show a dose response relationship. However, a dose response relationship is unlikely, because only a fixed proportion of health care utilization can probably be affected by providing high quality information and patient self-management. This study suggests

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that this proportion is at least 12%, although future studies with longer follow-up will provide more insight.

Comparison with previous studies

To our knowledge, this is the first study to evaluate the effects of providing evidence-based online health information on healthcare utilization rates in the general population. A previous study implemented online health information and found no change in health care utilization.[17] However, this study was only locally based, underpowered and health care utilization was assessed by self-reporting, which underestimates actual health care utilization.[33, 34] Other studies in this field mainly addressed characteristics, motivations and choices of online health information seekers. Most of these studies suggested that online health information seekers tend to make more doctor visits and that online health information is supportive during consultations but does not replace consultations.[11, 13-15] However, these studies are hampered by low response rates and only use self-reported health care utilization as an outcome. In addition, patient-specific characteristics could have confounded the results of these studies. For example, patients with low health anxiety make fewer doctor visits when looking online than patients with moderate to high anxiety.[12] Furthermore, the current online health information is of inconsistent quality,[7] highlighting the importance of providing high quality online information. Our findings in the young-age subgroup are in line with a recent study which found no change in health care utilization for infants.[16] This suggests that the need for assurance by face-to-face contact cannot be replaced by e-health in this patient group. The

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decrease in consultation rate was also present in the oldest subgroup. This refutes concerns about accessibility of older patients to online content and supports earlier positive findings of e-health in this age group.[35, 36]

Implications and future research

The majority of literature on this topic is focussed on whether e-health can be a replacement or is merely supplemental to regular health care. This simplifying approach separates the role of the physician from the patients' self-management. In the Netherlands, 90% of the GPs use www.thuisarts.nl as a supportive tool during their consultations and patients subsequently look up the provided information online.[23] This emphasizes the suitability of e-health as a tool to integrate self-management in primary care. In our opinion, the reduction of consultations for non-life-threatening conditions in primary care is beneficial and stimulates self-management of patients. Additionally, it could improve efficiency of communication during consultations, because patients are better informed. This model of blended care has also been adopted in other fields of medicine[37, 38] and this study shows its full potential for the first time. Because not all health topics are suitable for blended care, future studies could focus on suitability of specific topics for eHealth and improvement of information for these topics. We expect that our results are generalizable to other countries with other health care systems, because patients look for online health information and make a decision to visit a doctor in other countries as well. Still, effect sizes could be different in other countries, because internet penetration differs among countries.[39] Furthermore, evaluating effects of other health websites, for example in the UK (www.nhs.uk/Conditions) and online

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patient portals (e.g. patient.info, patientslikeme.com), might yield further insights in the possibilities of the internet on health care consumption. Finally, future studies could investigate the economic impact of this intervention.

Conclusion

The effect of providing evidence based online health information on health care utilization on a population level was not yet known. This study showed that, two years after the launch of an evidence based health website, nationwide primary care utilization decreased with 12%. This effect was most prominent for phone consultations and present in all subgroups of sex, SES and age, except for the youngest age group. This suggests that e-health can be effective to improve self-management and reduce health care utilization in times of increasing health care costs.

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Declaration of competing interests

The authors TD and IJMS are employed by the Dutch College of General Practitioners, which financially supports the website thuisarts.nl. These authors did not play a role in the design and analysis of this study. The authors WAS, TNB, MWMW MMJM and NHC declare no conflict of interest.

Author contributorship

WAS and TNB designed the study, analysed the data, interpreted the data and drafted the paper. MWMW and NHC designed the study, interpreted the data and revised the paper. TD and IJMS revised the paper. MMJM interpreted the data and revised the paper.

Data sharing

Technical appendix, statistical code, and dataset available from the last author (NHC).

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Figure legends

Figure 1. Rate of primary care consultations and page views of the website. Consultation rates with trend lines are displayed on the left y-axis. The number of page views of the website is displayed on the right y-axis and shows a steep increase in march 2012, which represents the launch of the website.

Figure 2. Rate of short, long and consultations by phone with trend lines.

Figure 3. Rate of consultations in the top 10 topics of the website and reference group with trend lines.

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Tables

Table 1. Change in consultation rate before and after the launch of the website in march 2012 for all consultations, the top 10 topics of the website and the reference group.

Type of consultations	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-value
All consultations	272.109	0.826	-0.794	-1.620	<.001
Top 10 topics	28.408	0.092	-0.077	-0.169	.003
Constipation	2.070	0.026	-0.007	-0.033	<.001
Vaginal discharge	1.665	0.013	-0.016	-0.029	<.001
Irritable bowel syndrome	1.019	0.009	-0.003	-0.011	<.001
Herpes zoster	0.504	0.002	-0.001	-0.003	<.001
Bladder infection in women	13.664	0.090	-0.011	-0.101	.009
Lower back pain	6.200	0.012	-0.013	-0.025	.03
Gout	0.794	0.008	0.004	-0.004	.38
Shoulder complaints	4.334	0.000	-0.004	-0.005	.46
Diarrhoea	3.311	-0.008	-0.013	-0.005	.72
Sinusitis	2.922	-0.007	-0.015	-0.008	.76
Reference group	4.611	-0.005	-0.006	-0.001	.96
Head Trauma[b]	0.389	0.001	0.001	0.000	.94
Premenstrual syndrome[c]	0.029	0.000	0.000	0.000	.92
Contact eczema[c]	4.195	-0.006	-0.007	-0.001	.96

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0
[b] Consultations for topics about which no online information was provided during the study period
[c] Consultations for topics that were very unpopular on the website during the study period

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Table 2. Subgroup analyses of change in consultation rate before and after the launch of the website in march 2012.

Subgroups	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-value
Male	218.036	0.558	-0.551	-1.109	.004
Female	325.262	1.066	-1.037	-2.103	<.001
Age <16	202.665	-0.083	-0.647	-0.563	.37
Age 16-40	229.494	0.533	-0.713	-1.245	<.001
Age 41-70	297.084	0.881	-0.873	-1.754	<.001
Age >70	462.495	2.545	-1.604	-4.149	<.001
Low SES	277.038	1.302	-0.914	-2.216	.001
Intermediate SES	277.756	0.608	-0.620	-1.228	<.001
High SES	259.988	0.692	-0.897	-1.589	<.001

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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Figures

Figure 1

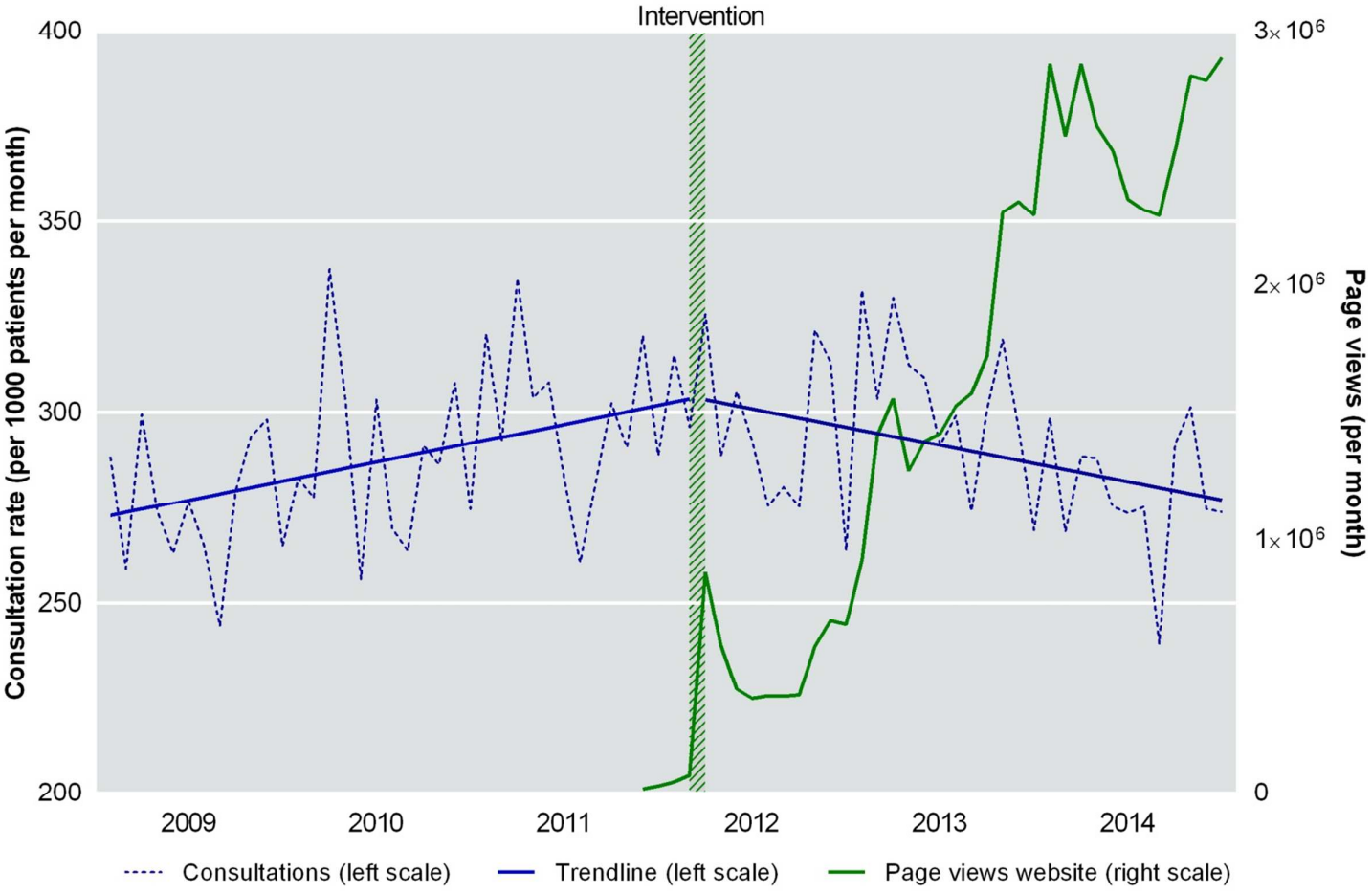

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Figure 2

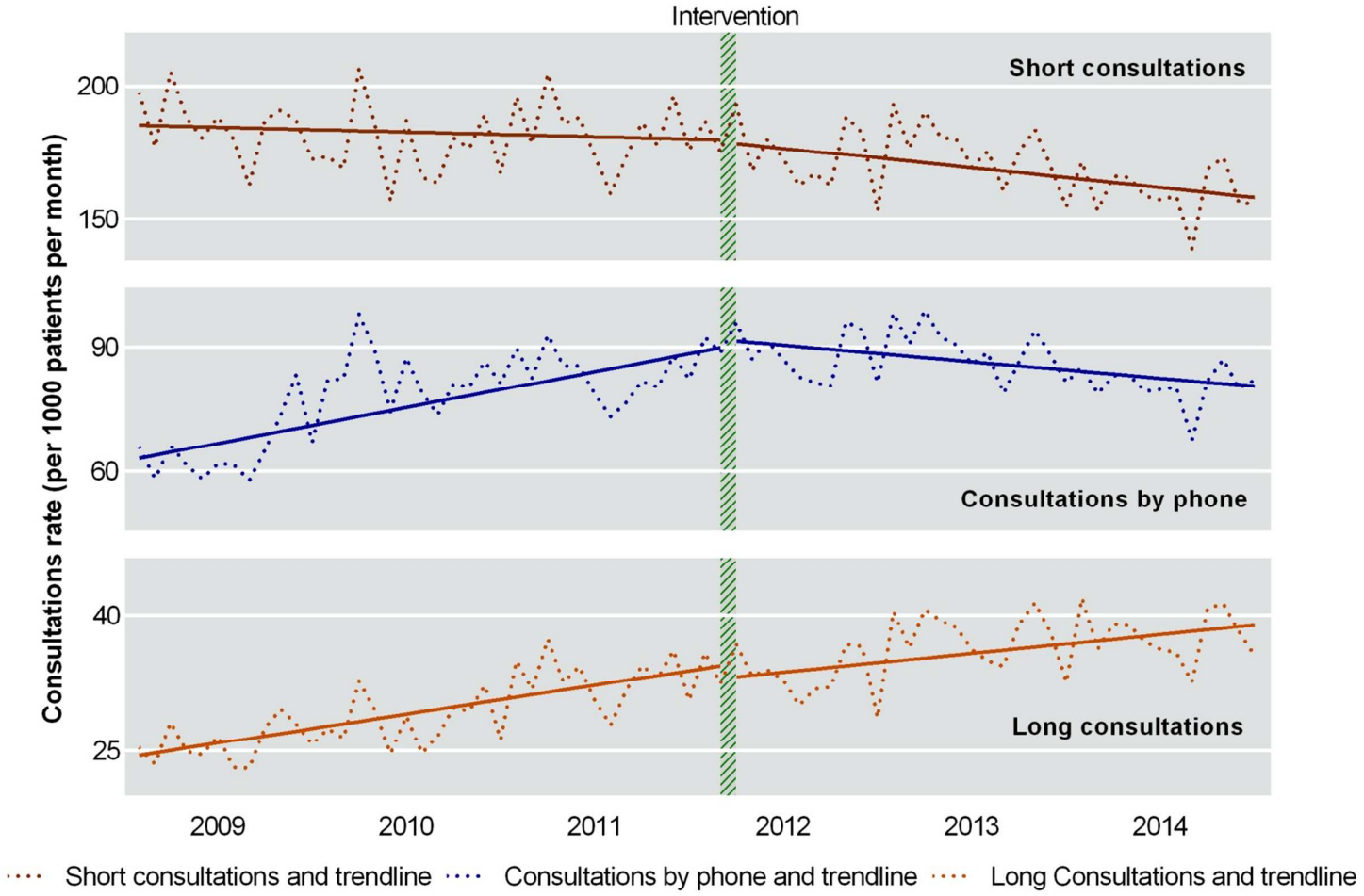

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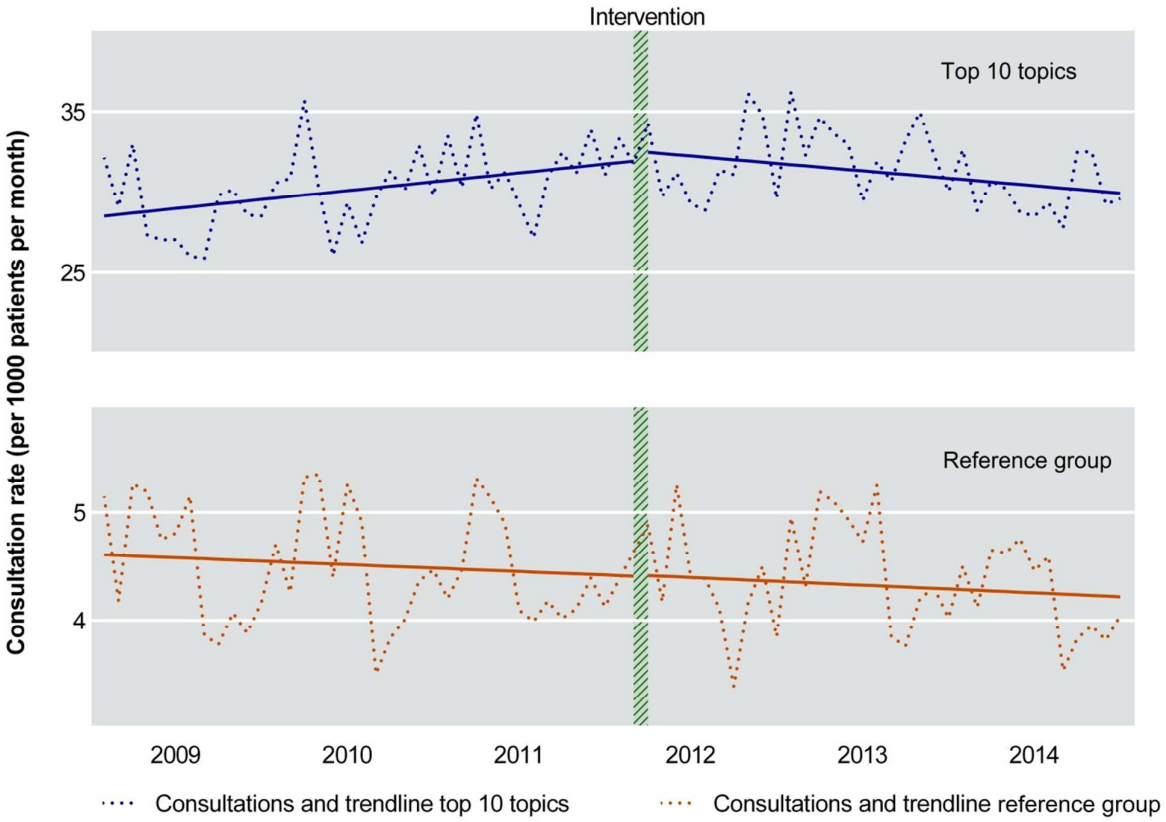
Figure 3



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Supplement

Supplement to: Spoelman WA, Bonten TN, de Waal MWM, et al. Evidence-based health website reduces health care use: a nationwide natural experiment

Contents

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eTables

eTable 1. Change in consultation rate before and after the launch of the website in march 2012, stratified for type of consultation.

Consultation type	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-value
Short	185.095	-0.142	-0.603	-0.461	.097
Telephone	62.357	0.726	-0.330	-1.056	.001
Long	24.234	0.267	0.172	-0.095	.152

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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eTable 2. Level change in consultation rate 1 and 2 years after the launch of the website

	1 year after website release			2 year after website release		
Type of consultations	Absolute slope change	Relative slope change	P-value	Absolute slope change	Relative slope change	P-value
All consultations	-20.458	-6.3%	.02	-39.901	-11.6%	.003
Top 10 topics	-1.574	-4.6%	.14	-3.607	-10.1%	.02

Values are presented as consultations/1000 patients/month

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eTable 3. Change in consultation rate before and after the launch of the website, including only high-grade ICPC recording (>95%) family physicians.

Type of consultations	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-Value
All consultations	269.790	0.553	-0.680	-1.234	.03
Top 10 topics	31.246	0.034	-0.117	-0.151	.02
Reference group	4.787	0.002	-0.022	-0.024	.05

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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eTable 4. Change in consultation rate before and after the launch of the website, including only family physicians recording throughout the entire study period.

Type of consultations	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-Value
All consultations	278.473	0.739	-1.253	-1.992	<.001
Top 10 topics	29.895	0.042	-0.104	-0.146	.02
Reference group	4.951	-0.007	-0.001	0.006	.66

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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eTable 5. Change in consultation rate before and after the launch of the website stratified for chronic care[a] and non-chronic care.

Type of consultations	Constant[b]	Pre-intervention slope	Post-intervention slope	Slope change	P-Value
Chronic care*	31.959	0.136	-0.097	-0.233	.005
Non-chronic care	240.168	0.692	-0.697	-1.389	<.001

Values are presented as consultations/1000 patients/month

[a] Chronic care was defined as the consultations typically performed by the nurse practitioner: Diabetes Mellitus (T90), COPD (R95), Asthma (R96) and cardiovascular disease/risk management (K49, K74, K75, K76, K85, K86, K87, K89, K90, K92 and K99)

[b] Consultation rate at t=0

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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Page 2
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Page 5, 6
Objectives	3	State specific objectives, including any prespecified hypotheses			Page 5, 6
Methods					
Study Design	4	Present key elements of study design early in the paper			Page 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Page 6
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the		RECORD 6.1: The methods of study population selection (such as codes or	Page 6, 7

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		sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 7, 8, 9
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Page 7, 8, 9
Bias	9	Describe any efforts to address potential sources of bias			Page 7, 8, 9
Study size	10	Explain how the study size was			Page 6

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		arrived at			
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Page 7, 8, 9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 9, 10
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-	Page 6, 7

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				level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Page 10
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Page 10
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			Page 10, 11
Main results	16	(a) Give unadjusted estimates			Page 10, 11

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		and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			Page 11
Discussion					
Key results	18	Summarise key results with reference to study objectives			Page 11, 12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 12, 13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Page 14, 15
Generalisability	21	Discuss the generalisability (external validity) of the study results			Page 14, 15

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Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Page 17
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	n.a.

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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BMJ Open

Effect of an evidence-based website on health care utilization: an interrupted time-series study

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Primary Subject Heading:	Communication
Secondary Subject Heading:	Evidence based practice, General practice / Family practice, Health informatics, Medical education and training, Public health
Keywords:	PRIMARY CARE, PUBLIC HEALTH, eHealth, health care utilization, interrupted time series, health communication

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Effect of an evidence-based website on health care utilization: an interrupted time-series study

Short title: website use and health care utilization

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Abstract

Objectives – Health care costs and utilization are rising. Evidence-based online health information may reduce health care utilization, but the evidence is scarce. The objective of this study was to determine whether the release of a nationwide evidence-based health website was associated with a reduction in health care utilization.

Design – Interrupted time series analysis of observational primary care data of health care use in the Netherlands from 2009 to 2014.

Setting – General community primary care.

Population – 912 000 patients who visited their general practitioners 18.1 million times during the study period.

Intervention – In march 2012, an evidence-based health information website was launched by the Dutch College of General Practitioners. It was easily accessible and understandable using plain language. At the end of the study period, the website had 2.9 million unique page views per month.

Main outcomes measures – Primary outcome was the change in consultation rate (consultations/1000 patients/month) before and after the release of the website. Additionally, a reference group was created by including consultations about topics not being viewed at the website. Subgroup analyses were performed for type of consultations, sex, age and socioeconomic status.

Results – After launch of the website, the trend in consultation rate decreased with 1.620 consultations/1000 patients/month (p<.001). This corresponds to a 12% decline in consultations two years after launch of the website. The trend in

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consultation rate of the reference group showed no change. The subgroup analyses showed a specific decline for consultations by phone and was significant for all other subgroups, except for the youngest age group.

Conclusions – Health care utilization decreased with 12% after providing high quality evidence-based online health information. These findings show that eHealth can be effective to improve self-management and reduce health care utilization in times of increasing health care costs.

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Article summary

Strengths and limitations of this study

- Long-term follow-up (6 years) in large number of health care consultations (18.1 million)
- An interrupted time series analysis is the strongest research design when randomisation is not possible
- A change in trend of the outcome before and after the intervention and additional use of a reference group supports a causal effect of the intervention
- Actual health care utilization rates based on registries were used, instead of self-reported health care use
- Other events might have affected health care utilization during our study period, but were carefully considered and analysed in sensitivity analyses which showed similar results as the primary analysis

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Introduction

Health care costs and utilization are rising in western countries and projected to increase even faster due to the ageing population.[1-3] Health care workers and policy makers are seeking ways to control health care costs and utilization while simultaneously improving health care quality. An important reason for patients to use health care is the need for information.[4] Many patients seek online for health information and use this information to decide whether or not to visit a doctor.[5 6] So, in theory, patients using online health information are well-informed and make a better assessment on the need to visit a doctor, leading to lower utilization of health care. However, online health information is of inconsistent quality[7] and evidence for the effects on health care utilization is scarce. Previous studies showed heterogeneous results: online information did not change or even increased health care utilization in some studies.[8-17] An important limitation of these studies is that most estimated health care utilization by patient self-reporting instead of actual health care utilization statistics. Furthermore, the effects of online health information might be different in subgroups of sex, socioeconomic status (SES) and age. Online health information seekers are mostly young women with a high SES.[5 18-21] A recent study, investigating the effect of an online support programme on health care utilization in infants, found no difference in this youngest-age subgroup.[16]

The Dutch College of General Practitioners (NHG) launched a non-commercial evidence based, public website in the Netherlands in march 2012.[22] The NHG is the Dutch scientific society of general practitioners (GPs), and publishes and updates nationally implemented evidence-based guidelines.[23] The content on the website is

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based on those guidelines. The primary goal of the website was to provide reliable and understandable medical information.[22] Since its launch, the website has grown to become one of the most visited health care website in the Netherlands. However, its effect on health care utilization is not yet known. We therefore conducted a nationwide study to test the hypothesis that providing evidence-based online health information is associated with a reduction of health care utilization. Secondly, we investigated whether the effect on health care utilization differed by sex, age and SES.

Methods

Design, participants and care setting

We used a natural before-after quasi-experimental design to study the number of consultations in primary care before and after the launch of the website (www.thuisarts.nl) in march 2012. Observational data were used from NIVEL Primary Care Database (http://www.nivel.nl/en/dossier/nivel-primary-care-database) from 2009 to 2014. This time period provides data points from three years before and nearly three years after the website launch, giving enough data points to evaluate changes in trends.[24 25]

The study was situated in the primary care system of the Netherlands. It consists of 5068 primary care practices for nearly 17 million inhabitants. Dutch GP consultations are fully covered by the mandatory basic insurance for all inhabitants. GPs function as gate-keepers for specialized care and thus are important as first-line contact for patients seeking health information and play a central role in health care utilization.

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To ensure data quality and prevent confounding by registration quality, only GPs were included who recorded more than 70% of their consultations with International Classification of Primary Care (ICPC) codes and provided data for the entire calendar year. Nationally representative data[26] of on average 230 general practitioners were sampled in each year, representing 911 177 inhabitants (5.4% of the total Dutch population). GP patient contacts and diagnoses are coded according to the ICPC-1.[27] Data were anonymized, but contained records for sex, age and zip codes for each patient. Dutch law allows the use of electronic health records for research purposes under certain conditions. According to this legislation, neither obtaining informed consent from patients nor approval by a medical ethics committee is obligatory for this type of observational studies containing no directly identifiable data (Dutch Civil Law, Article 7:458).

Data sharing

Technical appendix, statistical code, and dataset available from the last author (NHG).

Intervention

The website (www.thuisarts.nl) was launched in march 2012 by the Dutch minister of health, welfare and sports. Since then it is a publicly available non-commercial website, providing reliable medical information and advice.[22] All information and advice is based on the guidelines of the NHG and the online advice matches the

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most recent GP guidelines.[23] Guideline updates are synchronized with patient situations on Thuisarts.nl by a team of professionals.[22] The online content is thus evidence-based, is non-commercial, uses plain understandable language and covers over 600 topics. Each Thuisarts topic consists of several 'patient situations', for example: I need to start inhalation medication. Information on what to do and when to contact the GP is given. The situations can include illustrations, short video's, patient decision aids and e-health self-management tools like a self-test on alcohol use. The popularity of the website has grown exponentially, having currently 3 million unique page views each month.

Measurements

The primary outcome was defined as the trend in total number of consultations per 1000 patients per month before and after launch of the website. The total number of consultations was calculated in each month and divided by the number of quarterly enlisted patients, multiplied by 1000. Since the outcome was expected to have a seasonal fluctuation, a monthly interval was chosen to enable statistical control for seasonality as described below. The secondary outcome was the trend in consultation rate for a selection of top 10 popular topics on the website. A top 10 of the topic pages was created before starting the analyses and was based on the number of unique page views, which were extracted using google analytics. A unique page view was defined as the number of times a page was loaded by a visitor's browser. If a visitor viewed a page several times during a single session, it only counted as one page view. The following topics (ICPC codes) were selected using this criterion before conducting the analyses: herpes zoster (S70), lower back

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pain (L02 and L03), bladder infection in women (U71), vaginal discharge (X14), shoulder complaints (L08 and L92), gout (T92), constipation (D12), irritable bowel syndrome (D93), diarrhoea (D11, D70 and D73) and sinusitis (R75).

Primary analysis

The primary analysis consists of a comparison of health care use before and after the launch of the website. So, the most important control period was the period before release of the website. However, because changes in the health care system could have affected health care utilization after release of the website, we additionally incorporated a reference group with health topics that were not exposed to the intervention. These topics were selected before conducting the analyses and included when no online information was available or page views of the topic very low on the website during the study period. These topics were head trauma (N79 and N80), premenstrual syndrome (X09) and contact eczema (S88).

Subgroup and sensitivity analyses

Pre-specified subgroup analyses were performed for different type of consultations: short consultations (20 minutes or less), long consultations (more than 20 minutes) and consultations by phone. Furthermore, subgroups of sex, SES and age were analysed. SES groups were created based on the available zip codes and using data of the Netherlands Institute for Social Research. These SES scores are based on postal codes (area of residence) and provided as summary scores by the Netherlands Institute for Social Research.[28] Furthermore, four sensitivity analyses were performed. First, because website page views increased exponentially, we considered using a lag-time period after release of the website. Therefore, we

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calculated the relative and absolute level change 12 and 24 months after the intervention. The absolute level change between 12 and 24 months can thus be considered as the effect of the website with a lag-time of 12 months after the release. In the second sensitivity analysis we included only the GPs recording >95% of their consultations under an ICPC code, because an improvement in recording over time could have confounded the consultation rate of the secondary outcome. GPs participating the entire study period were included in the third sensitivity analysis, because a change of participating GP characteristics over time could have confounded the consultation rate over time. Fourth, due to changes in insurance policies, consultations performed for chronic care (asthma, COPD, diabetes and cardiovascular risk management) by nurse practitioners fluctuated during the study period. To exclude any influence of these fluctuations, we performed the primary analyses separately for chronic- and non-chronic care consultations.

Statistical analysis

All analyses, including subgroup analyses, were predefined in an analysis plan before the start of the analyses. The reference groups 'premenstrual syndrome' and 'contact eczema' were added post-hoc to strengthen the reference group comparison. To evaluate the longitudinal impact of the introduction of the website, an interrupted time series (ITS) analysis was used. ITS is considered a strong design when randomisation is not possible and can thus be used to study causal effects using an observational 'natural experiment' approach.[29] ITS measures the change in outcome, taking pre-existing trends in the data into account, thereby negating the effect of other factors influencing the outcome, provided that those factors remain

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constant.[24 25] So, the primary outcome's most important control period was the trend in consultation rate before release of the website. To additionally control for factors that did not remain constant after the release of the website, a reference group was created for consultations not exposed to the intervention.[29]

The Cochrane Collaboration guideline on ITS analyses was used, applying an autoregressive integrated moving average (ARIMA) model.[24] For the primary and secondary outcomes, the trends in consultation rate before and after the launch of the website in march 2012 were compared by calculating the slope change. Level changes at 12 and 24 months were estimated by forecasting the pre-intervention model and comparing this with the post-intervention model. For each subgroup and the reference group, a separate ARIMA model was fitted. Because an ARIMA model relies on linearity, we checked for stationarity of the mean and variance over time by differencing.[30] After differencing once, the time series reached stationarity, indicating linearity and appropriateness of an ARIMA model. We evaluated auto-correlation and seasonality by inspecting the autocorrelation (ACF) and partial autocorrelation functions (PACF), finding autocorrelations at lag 1 and 12. Hence, an ARIMA 1(1,0,0) model and seasonal ARIMA 12(1,0,0) model was fitted. After applying the model the ACF and PACF of the noise residuals were inspected and tested by using the Box-Ljung statistic, finding no relevant residual autocorrelations, which confirmed adequacy of the model.[25, 26] All analyses were performed in SPSS version 20.0 (IBM Corporation, New York, USA). Values were considered to be statistically significant at a p-value <.05.

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Results

The total number of consultations during the 6-year study period was 18.1 million, with a mean (SD) of 290 (21) consultations per 1000 patients per month. The mean (SD) age of the study population during the whole study period was 40 (23) years with 51% females (eTable 1). The total amount of unique page views of the website during the study period was 56.6 million, with a monthly mean of 450 000 in 2012 and increased to 2.9 million per month in the end of 2014 (figure 1). Trends of total number of consultations before and after the launch of the website are depicted in figure 1. Before the launch of the website, the consultation rate increased with 0.826/1000/month. However, after the launch of the website, this rate decreased to -0.794/1000/month, giving a slope change of -1.620 (p<.001; table 1). The slope for all consultation types declined (figure 2), but only the decline for telephone consultations significantly, with a slope change of -1.056 (p=.001; eTable 2).Trends for the secondary outcome are depicted in figure 3. The consultations for top 10 topics decreased (slope change: -0.169; p=.003; table 1), while the consultation rate for the reference group did not change (slope change: -0.001; p=.96; table 1). When analysed separately, the consultation rate decreased significantly for six of the top 10 topics. The consultation rate did not change significantly for any of the 3 reference topics (table 1).

Subgroup and sensitivity analyses

For all subgroups of sex, age and SES, the stratified analyses showed a significant decrease in consultation rate (table 2), except the youngest age group (0-16 years).

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In the first sensitivity analysis, calculating level changes one and two years after launch of the website, the consultation rate had decreased with 6.2% after one year and with 11.6% after two years (eTable 3). In our study population, this corresponds with a reduction of 62 300 consultations in the month march 2014. The second sensitivity analysis, including only high-grade recording GPs and the third sensitivity analysis, including only GPs recording throughout the entire study period, confirmed the results of the main analysis (eTable 4 and 5). In the fourth sensitivity analysis, a similar decrease in consultation rate was found for chronic- and non-chronic care consultations (eTable 6).

Discussion

Key results and interpretation

In this nationwide natural experiment, health care utilization in primary care decreased after the launch of an evidence-based health information website. This strongly suggests that, by providing evidence based online health information, health care utilization can be affected: in our study, consultation numbers decreased with almost 12% after two years. When extrapolated to the entire Dutch population, this translates to a reduction of 675 000 consultations in the month march 2014 only, exactly two years after the intervention. Interestingly, the decline was most distinct for the consultations by phone. Those consultations usually encompass non-essential care, and are therefore most likely to be affected by providing online information.[31] Importantly, health care use in the period before release of the website was not declining and even rising. In addition, a reference group was used to detect

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effects of other factors influencing consultation rates which were not accounted for by the pre-intervention trend. After release of the website, this reference group showed no change at all, which supports a causal relation between the launch of the website and the reduction of health care utilization. The reduction was robustly present in all the subgroups, except in the youngest age group. To our knowledge, this is the first study to evaluate the effects of providing evidence-based online health information on healthcare utilization rates in the general population. A previous study implemented online health information and found no change in health care utilization.[17] However, this study was only locally based, underpowered and health care utilization was assessed by self-reporting, which underestimates actual health care utilization.[32 33] Other studies in this field mainly addressed characteristics, motivations and choices of online health information seekers. Most of these studies suggested that online health information seekers tend to make more doctor visits and that online health information is supportive during consultations but does not replace consultations.[11 13-15] However, these studies are hampered by low response rates and only use self-reported health care utilization as an outcome. In addition, patient-specific characteristics could have confounded the results of these studies. For example, patients with low health anxiety make fewer doctor visits when looking online than patients with moderate to high anxiety.[12] Furthermore, the current online health information is of inconsistent quality,[7] highlighting the importance of providing high quality online information. Our findings in the young-age subgroup are in line with a recent study which found no change in health care utilization for infants.[16] This suggests that the need for assurance by face-to-face contact cannot be replaced by eHealth in this patient group. The decrease in consultation rate was also present in

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the oldest subgroup. This refutes concerns about accessibility of older patients to online content and supports earlier positive findings of eHealth in this age group.[34 35]

Strengths and limitations

The major strengths of this study are its before-after design and additional use of a reference group. The rise of consultation rates before release of the website, the decline after release of the website and the absence of change in consultation rate in the reference group supports a causal relation between the intervention and the observed effects. A limitation is that, due to nationwide implementation of the website, no reference group could be created which was not exposed to the website at all during the study period. As an alternative, we selected topics which were not on the website (head trauma) or had very low page views during the study period (premenstrual syndrome and contact eczema). They consider health topics for which self-management with online information is feasible and in our opinion thus form a valid reference group. Although the absolute number of consultations for these reference topics were substantially lower than the top 10 topics, they provide insight in the stability of health care utilization without exposure to the website. Another strength is that we investigated the impact of this eHealth intervention using actual health care utilization rates, instead of questionnaire based estimates. Importantly, our data is representative of the Dutch population.[26] Furthermore, we were able to create a long-term study duration of 6 years, providing enough data points to account for seasonality and pre-intervention trends. Although ITS is considered the strongest research design when randomisation is not possible and can in theory be used to study causal effects using observational data,[29] we carefully considered

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other events that might have affected health care utilization during our study period. For example, one of the main incentives for health care utilization are reimbursements. During our study period, a stepwise increase of the deductible to €360 in 2014 occurred. However, primary care consultations were always fully covered by the health insurance, while secondary care consultations were not. In addition a stable 3% of the Dutch population avoids primary care due to financial reasons[36], which cannot explain the decrease of 12% in consultation rate that we observed in this study. Another factor possibly influencing primary care consultation rate is fluctuations of chronic care consultations performed by nurse practitioners. We addressed this by stratifying our analysis for chronic- and non-chronic care consultations and found a similar decline of consultation rate for both. Furthermore, we considered a change over time of the general practice characteristics as a confounding variable for the primary outcome and a change in registration grade as a confounding variable for the secondary outcome. After including only general practitioners which participated throughout the entire study period and after including only high-grade recording general practitioners, a similar decline in trend was found as in the main analysis. Additionally, an increase of the population's age over time could have affected our results. Our population's age increased with 0.9 years during the study period (eTable 1). In our opinion, this would not have a large impact on our primary results, and if any, this would lead to a larger effect of the intervention .Although the website reached 3 million page views by the end of 2014, the reduction in health care use did not show a dose response relationship. However, a dose response relationship is unlikely, because only a fixed proportion of health care utilization can probably be affected by providing high quality information and patient

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self-management. This study suggests that this proportion is at least 12%, although future studies with longer follow-up will provide more insight. A limitation of our study is that we counted unique page views of the website, although counting unique visitors could have added valuable information. Using unique page views to quantify exposure of the website could over- or underestimate the number of unique visitors, but still provides important information about the uptake of the website by the public. Finally, mass media coverage about health care use or the website may have influenced health care consumption during the study period. However, the only mass media coverage about the website took place in march 2012 and no active media or marketing actions were carried out during the rest of the study period.

Generalisability and future research

The majority of literature on this topic is focussed on whether eHealth can be a replacement or is merely supplemental to regular health care. This simplifying approach separates the role of the physician from the patients' self-management. In the Netherlands, 90% of the GPs use www.thuisarts.nl as a supportive tool during their consultations and patients subsequently look up the provided information online.[22] This emphasizes the suitability of eHealth as a tool to integrate self-management in primary care. In our opinion, the reduction of consultations for non-life-threatening conditions in primary care is beneficial and stimulates self-management of patients. Additionally, it could improve efficiency of communication during consultations, because patients are better informed. This model of blended care has also been adopted in other fields of medicine[37 38] and this study shows its

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full potential for the first time. Because not all health topics are suitable for blended care, future studies could focus on suitability of specific topics for eHealth and improvement of information for these topics. Furthermore, our results do not imply that quality of care nor health of the population is increased by an evidence based health website. This could be a topic for future research. We expect that our results are generalizable to other countries with other health care systems, because patients look for online health information and make a decision to visit a doctor in other countries as well. Still, effect sizes could possibly be stronger in other countries without insurance cover for primary care or weaker when internet penetration is lower.[39] Furthermore, evaluating effects of other health websites, for example in the UK (www.nhs.uk/Conditions) and online patient portals (e.g. patient.info, patientslikeme.com), might yield further insights in the possibilities of the internet on health care consumption. Finally, future studies could investigate the economic impact of this intervention.

Conclusion

The effect of providing evidence based online health information on health care utilization on a population level was not yet known. This study showed that, two years after the launch of an evidence based health website, nationwide primary care utilization decreased with 12%. This effect was most prominent for phone consultations and present in all subgroups of sex, SES and age, except for the youngest age group. This suggests that eHealth can be effective to improve self-management and reduce health care utilization in times of increasing health care

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costs.

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Declaration of competing interests

The authors TD and IJMS are employed by the Dutch College of General Practitioners, which financially supports the website thuisarts.nl. These authors did not play a role in the design and analysis of this study. The authors WAS, TNB, MWMW MMJM and NHC declare no conflict of interest.

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Author contributorship

WAS and TNB designed the study, analysed the data, interpreted the data and drafted the paper. MWMW and NHC designed the study, interpreted the data and revised the paper. TD and IJMS revised the paper. MMJM interpreted the data and revised the paper.

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Figure legends

Figure 1. Rate of primary care consultations and page views of the website. Consultation rates with trend lines are displayed on the left y-axis. The number of page views of the website is displayed on the right y-axis and shows a steep increase in march 2012, which represents the launch of the website.

Figure 2. Rate of short, long and consultations by phone with trend lines.

Figure 3. Rate of consultations in the top 10 topics of the website and reference group with trend lines.

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Tables

Table 1. Change in consultation rate before and after the launch of the website in march 2012 for all consultations, the top 10 topics of the website and the reference group.

Type of consultations	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-value
All consultations	272.109	0.826	-0.794	-1.620	<.001
Top 10 topics	28.408	0.092	-0.077	-0.169	.003
Constipation	2.070	0.026	-0.007	-0.033	<.001
Vaginal discharge	1.665	0.013	-0.016	-0.029	<.001
Irritable bowel syndrome	1.019	0.009	-0.003	-0.011	<.001
Herpes zoster	0.504	0.002	-0.001	-0.003	<.001
Bladder infection in women	13.664	0.090	-0.011	-0.101	.009
Lower back pain	6.200	0.012	-0.013	-0.025	.03
Gout	0.794	0.008	0.004	-0.004	.38
Shoulder complaints	4.334	0.000	-0.004	-0.005	.46
Diarrhoea	3.311	-0.008	-0.013	-0.005	.72
Sinusitis	2.922	-0.007	-0.015	-0.008	.76
Reference group	4.611	-0.005	-0.006	-0.001	.96
Head Trauma[b]	0.389	0.001	0.001	0.000	.94
Premenstrual syndrome[c]	0.029	0.000	0.000	0.000	.92
Contact eczema[c]	4.195	-0.006	-0.007	-0.001	.96

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0
[b] Consultations for topics about which no online information was provided during the study period
[c] Consultations for topics that were very unpopular on the website during the study period

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Table 2. Subgroup analyses of change in consultation rate before and after the launch of the website in march 2012.

Subgroups	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-value
Male	218.036	0.558	-0.551	-1.109	.004
Female	325.262	1.066	-1.037	-2.103	<.001
Age <16	202.665	-0.083	-0.647	-0.563	.37
Age 16-40	229.494	0.533	-0.713	-1.245	<.001
Age 41-70	297.084	0.881	-0.873	-1.754	<.001
Age >70	462.495	2.545	-1.604	-4.149	<.001
Low SES	277.038	1.302	-0.914	-2.216	.001
Intermediate SES	277.756	0.608	-0.620	-1.228	<.001
High SES	259.988	0.692	-0.897	-1.589	<.001

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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figure 1

209x137mm (300 x 300 DPI)

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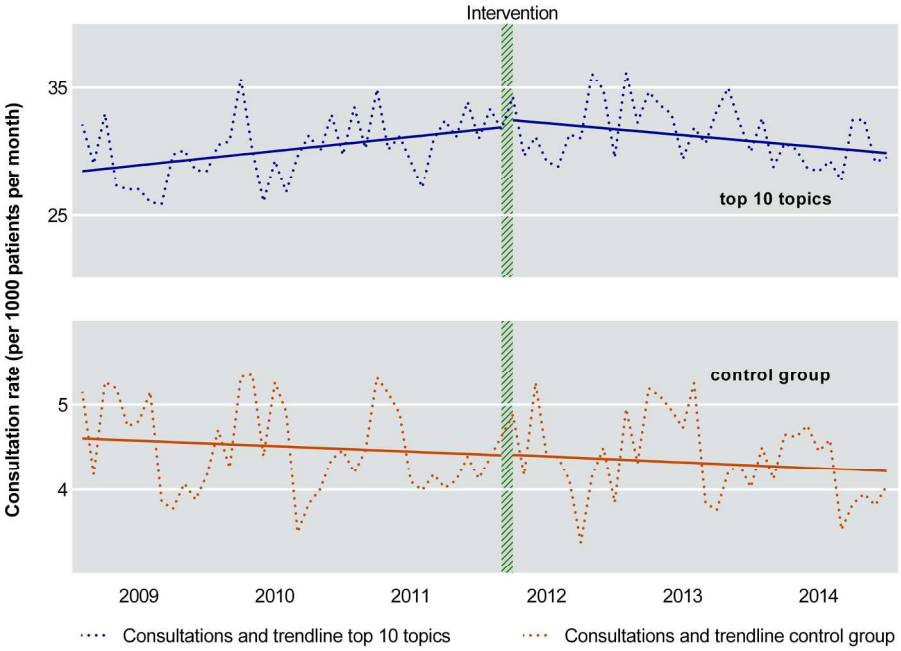

figure 2

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View only

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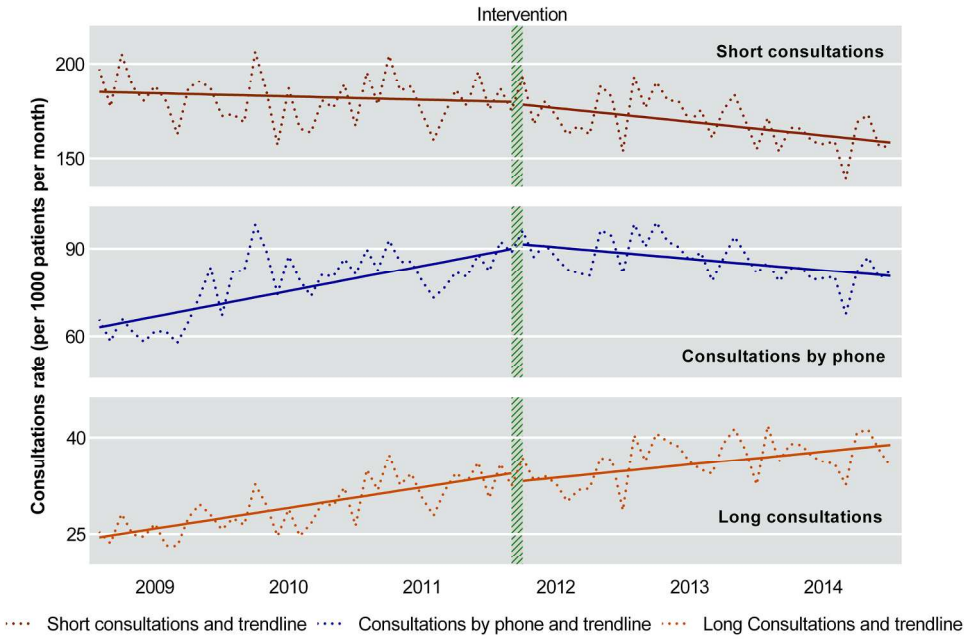

figure 3

207x137mm (300 x 300 DPI)

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Supplement

Supplement to: Spoelman WA, Bonten TN, de Waal MWM, et al. Effect of an evidence-based website on health care utilization: an interrupted time-series study

Contents

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eTables

eTable 1. Characteristics of the study population over time.

	Year					Whole study period
	2010	2011	2012	2013	2014	
N, total	637 467	1 143 455	695 316	1 009 195	1 638 602	5 124 035
Age (mean, sd)	39.3 (22.7)	39.4 (22.7)	40.5 (22.9)	40.5 (23.0)	41.0 (23.0)	40.2 (22.9)
Gender (% male)	49.5	49.1	49.4	49.3	49.4	49.3

SD: standard deviation

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eTable 2. Change in consultation rate before and after the launch of the website in march 2012, stratified for type of consultation.

Consultation type	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-value
Short	185.095	-0.142	-0.603	-0.461	.097
Telephone	62.357	0.726	-0.330	-1.056	.001
Long	24.234	0.267	0.172	-0.095	.152

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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eTable 3. Level change in consultation rate 1 and 2 years after the launch of the website

	1 year after website release			2 year after website release		
Type of consultations	Absolute slope change	Relative slope change	P-value	Absolute slope change	Relative slope change	P-value
All consultations	-20.458	-6.3%	.02	-39.901	-11.6%	.003
Top 10 topics	-1.574	-4.6%	.14	-3.607	-10.1%	.02

Values are presented as consultations/1000 patients/month

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eTable 4. Change in consultation rate before and after the launch of the website, including only high-grade ICPC recording (>95%) family physicians.

Type of consultations	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-Value
All consultations	269.790	0.553	-0.680	-1.234	.03
Top 10 topics	31.246	0.034	-0.117	-0.151	.02
Reference group	4.787	0.002	-0.022	-0.024	.05

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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eTable 5. Change in consultation rate before and after the launch of the website, including only family physicians recording throughout the entire study period.

Type of consultations	Constant[a]	Pre-intervention slope	Post-intervention slope	Slope change	P-Value
All consultations	278.473	0.739	-1.253	-1.992	<.001
Top 10 topics	29.895	0.042	-0.104	-0.146	.02
Reference group	4.951	-0.007	-0.001	0.006	.66

Values are presented as consultations/1000 patients/month
[a] Consultation rate at t=0

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eTable 6. Change in consultation rate before and after the launch of the website stratified for chronic care[a] and non-chronic care.

Type of consultations	Constant[b]	Pre-intervention slope	Post-intervention slope	Slope change	P-Value
Chronic care*	31.959	0.136	-0.097	-0.233	.005
Non-chronic care	240.168	0.692	-0.697	-1.389	<.001

Values are presented as consultations/1000 patients/month
[a] Chronic care was defined as the consultations typically performed by the nurse practitioner: Diabetes Mellitus (T90), COPD (R95), Asthma (R96) and cardiovascular disease/risk management (K49, K74, K75, K76, K85, K86, K87, K89, K90, K92 and K99)
[b] Consultation rate at t=0

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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Page 2
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Page 5, 6
Objectives	3	State specific objectives, including any prespecified hypotheses			Page 5, 6
Methods					
Study Design	4	Present key elements of study design early in the paper			Page 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Page 6
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the		RECORD 6.1: The methods of study population selection (such as codes or	Page 6, 7

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		sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 7, 8, 9
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Page 7, 8, 9
Bias	9	Describe any efforts to address potential sources of bias			Page 7, 8, 9
Study size	10	Explain how the study size was			Page 6

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		arrived at			
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Page 7, 8, 9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 9, 10
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-	Page 6, 7

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				level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Page 10
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Page 10
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			Page 10, 11
Main results	16	(a) Give unadjusted estimates			Page 10, 11

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		and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			Page 11
Discussion					
Key results	18	Summarise key results with reference to study objectives			Page 11, 12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 12, 13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Page 14, 15
Generalisability	21	Discuss the generalisability (external validity) of the study results			Page 14, 15

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Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Page 17
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	n.a.

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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Correction

Spoelman WA, Bonten TN, de Waal MWM, *et al*. Effect of an evidence-based website on healthcare usage: an interrupted time-series study. *BMJ Open* 2016;6:e013166. doi: 10.1136/bmjopen-2016-013166

Figure 2 and Figure 3 were the wrong way round in the original publication. The correct Figures and their captions are shown below.

Figure 2 Rate of short consultations, long consultations and consultations by phone with trend lines.' actually displays the top 10 topics and the control group.

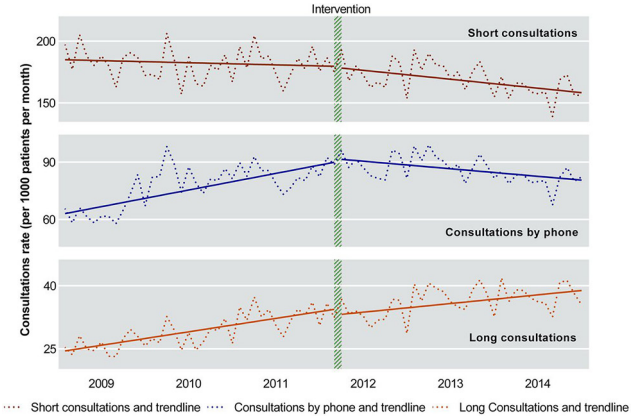
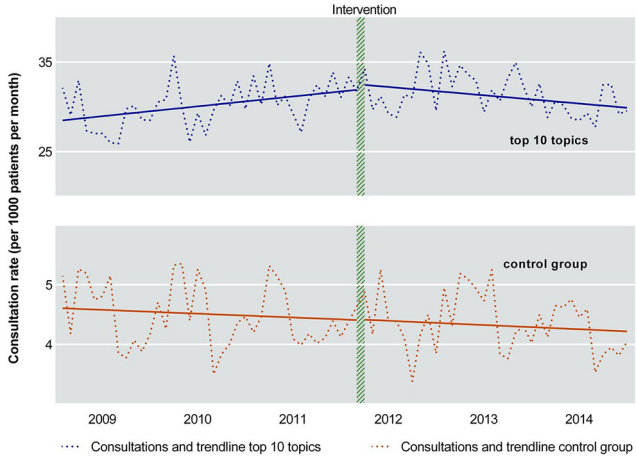


Figure 3 Rate of consultations in the top 10 topics of the website and reference group with trend lines.'



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