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Estimating community health needs against a Triple Aim background: What can we learn from current predictive risk models?

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ABSTRACT

Introduction: To support providers and commissioners in accurately assessing their local populations' health needs, this study produces an overview of Dutch predictive risk models for health care, focusing specifically on the type, combination and relevance of included determinants for achieving the Triple Aim (improved health, better care experience, and lower costs).
Methods: We conducted a mixed-methods study combining document analyses, interviews and a Delphi study. Predictive risk models were identified based on a web search and expert input. Participating in the study were Dutch experts in predictive risk modelling (interviews; $n = 11$) and experts in healthcare delivery, insurance and/or funding methodology (Delphi panel; $n = 15$).
Results: Ten predictive risk models were analysed, comprising 17 unique determinants. Twelve were considered relevant by experts for estimating community health needs. Although some compositional similarities were identified between models, the combination and operationalisation of determinants varied considerably.
Conclusions: Existing predictive risk models provide a good starting point, but optimally balancing resources and targeting interventions on the community level will likely require a more holistic approach to health needs assessment. Development of additional determinants, such as measures of people's lifestyle and social network, may require policies pushing the integration of routine data from different (healthcare) sources.

1. Introduction

Amidst pressures to slowdown the level of public spending on health, many Western governments have to sustain an ageing population with increasing and changing long-term health needs [1]. Community-focused, integrated care is seen as an important means to meet this challenge, and is promoted as such in current policies across the globe. In both England and the United States, for example, provider networks – called clinical commissioning groups (CCGs) and accountable care organisations (ACOs), respectively – were recently introduced to encourage clinicians to reshape services in a more joined-up and seamless way

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that meets local population health needs [2,3]. Similarly, in 2013, the Dutch Minister of Health, Welfare and Sports appointed nine intersectoral provider networks aiming to rearrange health services based on population needs as 'pioneer sites' to be monitored over the coming years [4]. Ultimately, these policies are thought to push towards achieving the so-called 'Triple Aim' formulated by Berwick et al. [5], that is, improved population health, better care experience, and lower overall per capita costs.

Actually creating community-focused, integrated care in practice is nevertheless a daunting task, with many international health systems still characterised by fragmented organisational structures [6]. Changes are needed, amongst others, in funding models, operations and processes, and performance measurement [7]. However, one basic condition to make any endeavour towards the Triple Aim actionable is the ability to accurately estimate local populations' health needs and use this information to design, specify and procure services that meet those needs, within the resources available [8]. Thus, one of the primary aims of introducing CCGs in England was to increase GPs' influence in commissioning services for their communities, based on the premise that using GPs' clinical knowledge will lead to more informed, efficient resource allocation. CCGs are now responsible for commissioning the majority of health services, including elective hospital care and community services, and control around two-thirds of the English NHS budget [3]. In the US, the introduction of ACOs has similarly transferred a degree of financial responsibility to healthcare providers. When an ACO succeeds in both delivering high-quality care and slowing spending growth, it shares in the savings it achieves [3].

While governments underwrite the importance of 'continual analysis of community health needs' to enable execution of the Triple Aim, it is generally left up to provider networks like CCGs and ACOs to develop or acquire a suitable instrument to do so [9,10]. In many countries, this has led to a renewed interest in predictive risk models, which use relationships in historic, administrative health data to estimate the future health service use and/or costs of individuals or populations [11]. However, given the complexity and sheer number of available alternatives, choosing a predictive risk model is not an easy task for provider networks. Moreover, considerable debate has sparked in some countries, amongst which the Netherlands, about the value of existing predictive risk models for predicting community health needs against a Triple Aim background. Concerns are, for example, that efficiency is impossible to incentivise when estimations of future needs are based on past service consumption, as is the case in most current models. Also, there is a lack of insight into which determinants are relevant to predict population health needs when seeking to fulfil the Triple Aim through community-based, integrated care. The aim of this paper is to further the debate in the Netherlands, while at the same time sharing relevant insights with stakeholders in other countries facing similar challenges. For this purpose, an overview is presented of current Dutch predictive risk models, focusing specifically on the type and combination of included determinants and their relevance for estimating population health needs against a Triple Aim background.

2. Methods

To produce and analyse a compositional overview of Dutch predictive risk models, we applied a mixed-methods approach combining document analyses, interviews, and a Delphi study. Predictive risk models were identified based on a web search and input from the study's Scientific Advisory Board, which gathered representatives from eight professional bodies, including national associations of GPs, nurses and health insurers, primary and integrated care associations, and the Dutch Healthcare Authority and Ministry of Health, Welfare and Sports. To search the web, we entered Dutch search terms related to health needs assessment – e.g. 'prediction of care needs', 'prediction of care demands', 'prediction of care use', 'prediction of care costs' – into the Google search engine. The output of the web search was presented to the Scientific Advisory Board, which added further suggestions for models not identified online. To be included in the study, models had to: (1) combine two or more determinants correlated with health service use or costs (as a reflection of health needs [12]); (2) use these determinants prospectively to estimate and/or influence future service use or costs; and (3) focus on general practice, chronic care (delivered by primary care-based provider networks) and/or community care. Based on these criteria, a purposive sample of predictive risk models was included.

To collect qualitative data on these models, we did an extensive document study synthesizing evidence from articles and reports on model development, model updates and/or performance evaluations. In case of newer, less well published models, we complemented any available documentation with semi-structured interviews with one or more key informant(s) actively involved in the model development. Thus, one researcher (AE) conducted nine interviews with eleven key informants. The interview guide covered the following issues: (1) model objectives; (2) basic model features; and (3) included determinants. With permission of the respondents, all interviews were recorded and transcribed.

Document and interview data were analysed descriptively using a purposely-built data matrix based on the interview guide. The determinants included in each model were extracted and classified according to Andersen and Newman's Behavioural Model of Health Service Use [13]. This theoretical framework, which is one of the most widely used models for analysing health care utilisation [14,15], assumes that people's health care consumption is a function of societal determinants, health system features, and individual determinants (see Fig. 1). The latter constitute the focus of this study and can be differentiated into predisposing, enabling and illness level factors. Predisposing factors relate to people's personal predisposition to use health services and include, for example, age and sex. Enabling factors are contextual variables, like income and health insurance status, which can either support or impede an individual's service use. Illness level factors, finally, are indicators of health status – both perceived and evaluated – such as the presence of a chronic disease [13–15].

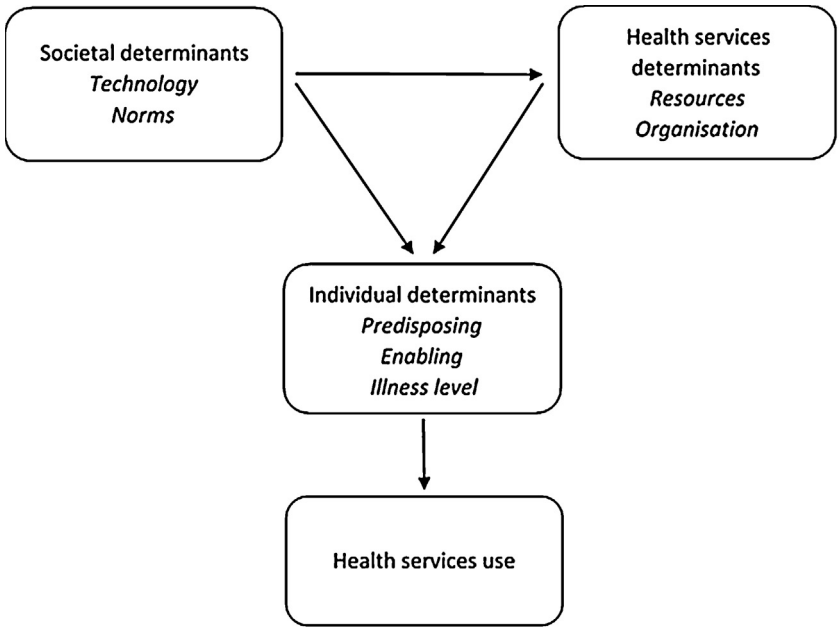

Fig. 1. Andersen and Newman's behavioural model of health service use [14].

To explore the relevance of the identified determinants for predicting future health needs on the community level against a Triple Aim background, we did a Delphi study with a mixed panel of Dutch experts, who met the following criteria: (1) professional expertise in health care delivery, health insurance and/or health care funding; and (2) a background in general practice, chronic care and/or community care. Fifteen experts were invited by email to participate.

We used the RAND/UCLA appropriateness method to design three Delphi rounds [16]. Round 1 was an online survey in which experts rated the relevance of each determinant – ordered according to frequency of appearance across models – on a nine-point Likert scale from 1 (totally irrelevant) to 9 (extremely relevant). We did univariate analyses of the online survey scores to determine the median and interquartile range (IQR) per factor, representing the overall assessment of relevance and degree of group consensus, respectively. Consensus for relevance was defined as a median between 7 and 9 combined with an IQR $\leq$ 1.5 [17]. Medians between 1 and 3 combined with an IQR $\leq$ 1.5 pointed to consensus for irrelevance, while all other possible outcomes (median 4–6 and/or IQR > 1.5) suggested uncertainty. Determinants with an uncertain rating were included in the second Delphi round, which was a face-to-face expert meeting to discuss scoring argumentation and, where possible, increase group consensus. Finally, in round 3, experts re-assessed the relevance of previously uncertain determinants on a personalised, paper-based survey comprising the median score and IQR per determinant, as well as their own rating as a reminder.

3. Results

3.1. An overview of Dutch predictive risk models

The exploration of Dutch practice yielded 15 predictive risk models, 10 of which met all three inclusion criteria and were developed far enough to enable determinant extraction. Table 1 shows some basic features of these 10 models. Four have been applied in practice for several years, whereas six are relatively new and currently being piloted. Although the models have different objectives, they generally seek to: (1) compensate health insurers and/or providers for a higher burden of disease in their client population (models B, C and D); (2) stimulate coordination and cooperation between community and primary care services (models E and F); and/or (3) enable planning, provision and/or commissioning of health care services based on the (future) health needs of distinct populations (models A, G, H, I and J).

Across the 10 models, a total of 17 unique determinants were identified (see Table 2). On average, models combine 3 to 11 of these factors to predict future health service use and/or costs, as a reflection of population health needs. In terms of combinations of determinants, five models comprise predisposing as well as enabling and illness level factors, whereas one model includes only illness level factors. The remaining four models combine predisposing with either enabling or illness level factors. The following sections further explore the types of extracted determinants and their relevance for estimating health needs on the community level. An overview of the operationalisation of determinants per model is provided in Appendix 1.

3.2. Predisposing (person-related) determinants

Table 2 shows the predisposing determinants included in the 10 Dutch predictive risk models. Age, a demographic characteristic, is most consistently used as a proxy measure of health needs. The differentiation of this factor into age bands, however, differs considerably between models from 6 to 20. Some models combine age with another

Table 1
Overview of included Dutch predictive risk models.

No.	Model	Year of origin	Developer	Focus area	Objective(s)	Status
A	Demand–supply analysis monitor ['Vraag Aanbod Analyse Monitor']	2005	NIVEL/NPCF	Primary care	To support the ongoing debate about how to adjust the provision of primary care services to local demands	In use
B	GPs' deprivation fund ['Achterstands-fonds Huisartsen']	1996	NIVEL	General practice	To compensate general practitioners in deprivated geographical areas for the higher workload and -pressure	In use
C	Risk equalisation somatic care ['Risicoverevening somatische zorg']	1993	CVZ	Somatic care	To compensate health insurers for predictable, health-related cost differences among insured	In use
D	Risk equalisation mental health care ['Risicoverevening geneeskundige GGZ']	2014	CVZ	Mental health care	To compensate health insurers for predictable, health-related cost differences among insured	In use
E	District and Practice Scan ['Wijk- en Praktijkscan']	2012	Jan van Es Instituut	Primary care	To facilitate optimal choices for health care provision, regional coordination and efficiency by providing insight into the population and care demands for primary care organisations, municipalities and health insurers	Piloting
F	District nursing teams ['Wijkzorgteams']	2013	Gemeente Amsterdam	District nursing	To facilitate integrated care tailored to local needs within long-term care and support by community care teams, with a focus on more self-reliance	Piloting
G	Segmentation model chronic care ['Segmentatiemodel chronische zorg']	2013	Achmea	Chronic care	To increase the level of efficiency in providing and purchasing integrated care for chronic conditions	Piloting
H	INtegrated CAre (INCA) model	2012	Acsion/Casemix	Chronic care	To facilitate integrated, coordinated care provision, tailored to the specific care needs of (multimorbid) patients To support health care purchasers through transparent information on actual care needs	Piloting
I	Predictive model ambulatory elderly care costs ['Voorspelmodel extramurale ouderenzorgkosten']	2013	Menzis	Elderly care	To determine the height of the lump sum budget for population-based purchasing of ambulatory elderly care	Piloting
J	Function profiles of elderly ['Functioneringsprofielen van ouderen']	2013	TNO	Elderly care	To predict the future demand for health care in a given region based on the function profiles of elderly	Piloting

demographic variable, which is sex, to compose separate age bands for men and women. Sex is included as a prognostic variable in a total of four models, so as to account for higher service use by women.

Five models use ethnicity as a determinant, thus accounting for higher health service use and/or costs among primarily non-western immigrants in The Netherlands. One model includes lifestyle as a predisposing factor for health care consumption, looking specifically at smoking status, overweight, and alcohol consumption.

3.3. Enabling (context-related) determinants

In addition to predisposing determinants, most Dutch predictive risk models recognise the impact of enabling factors on health service use and/or costs (see Table 2). The scope of these contextual variables varies across models, albeit that many are socio-economic in nature. Income is most frequently used: seven models reflect the impact of either income source (e.g., self-employment, disability benefit, social security benefit) or level (low or high income) on expected health care consumption. Additionally, four models interact household income with age to determine socio-economic status (SES).

Six models account for geographic disparities, both in terms of population and environment (e.g., municipal size, degree of urbanisation) and/or available care services (e.g., number of general practices, nursing homes, hospitals). Household is included five times, looking specifically at the type of household (e.g., single, married, family) or size (i.e., one or multiple person-address) to address higher use of professional care among people living alone. Two models incorporate the influence of housing circumstances on health care consumption, based on data about the financial value of a house versus the perceived suitability for growing old there. Finally, one model recognises the influence of people's social network on their need for professional care, using data concerning frequency of informal contacts, degree of (serious) loneliness, and share of the population receiving informal care.

Table 2
Predisposing, enabling and needs determinants per predictive risk model (A–J).

	A	B	C	D	E	F	G	H	I	J	
Predisposing determinants											
Age	*	–	*	*	*	*	*	–	*	–	7
Ethnicity	*	*	–	–	*	*	–	–	*	–	5
Sex	*	–	*	*	–	–	–	–	*	–	4
Lifestyle	–	–	–	–	–	–	–	*	–	–	1
	3	1	2	2	2	2	1	1	3	0	
Enabling determinants											
Income	*	*	*	*	*	*	–	–	*	–	7
Geography	*	*	*	*	*	–	–	–	*	–	6
Household	*	–	–	*	*	*	–	–	*	–	5
Socioeconomic status	–	–	*	*	*	–	*	–	–	–	4
Housing	–	–	–	–	*	*	–	–	–	–	2
Social network	–	–	–	–	–	*	–	–	–	–	1
	3	2	3	4	5	4	1	0	3	0	
Needs determinants											
Somatic illness	–	–	*	–	*	*	*	*	–	*	6
Mental illness	–	–	–	*	*	*	*	*	–	*	6
Functional status	–	–	*	–	*	*	*	–	–	*	5
Prior service use	–	–	–	–	*	*	*	–	–	–	3
Prior costs	–	–	*	*	–	–	*	–	–	–	3
Experienced health	–	–	–	–	–	*	–	–	–	*	2
Medication use	–	–	–	–	–	–	*	–	–	–	1
	0	0	3	2	4	5	6	2	0	4	

Note: A denotes demand–supply analysis monitor; B, GPs' deprivation fund; C, risk equalisation somatic care; D, risk equalisation mental health care; E, district and practice scan; F, district nursing teams; G, segmentation model chronic care; H, INtegrated CAre (INCA) model; I, predictive model ambulatory elderly care costs; J, function profiles of elderly.
* indicates inclusion of determinant in a predictive risk model.

3.4. Illness level (health-related) determinants

Seven predictive risk models reflect the determinative effect of health status on people's health care utilisation and/or costs (see Table 2). Most notably, physical and mental (chronic) health problems, including comorbidities, are each included six times as illness level factors based on individual clinical data. The Dutch risk equalisation schemes for somatic and mental health care (models C and D, respectively), for example, group individuals into diagnostic and pharmaceutical cost groups (DCGs and PCGs) to capture the costs associated with chronic illness in primary and secondary care. Functional status is recognised as a determinant of health service use in five models, mainly focusing on limitations in activities of daily living (ADL) and/or instrumental activities of daily living (IADL). Some models operationalise functional status as the percentage of frail elderly in a given region or through functional disability classes, which are clinically homogeneous groups based on prior durable medical equipment use.

Three models include prior service use as a predictor of future health care consumption and/or costs, for example based on data about the number of GP visits, hospital admissions or indications for home care in the previous year. Prior health care costs are also recognised as an illness level factor three times, given the association with future expenditures. For instance, the Dutch risk equalisation scheme for somatic care includes a 'multiple-year high cost' variable. Finally, two models recognise the effect of people's personal experience of their own health on service use, whereas medication use – not as an indicator of chronic disease (which is reflected in PCGs) but as a separate factor, looking at the number of different medications with a use of >180 DDD – is included once.

3.5. Relevance of determinants for community health needs assessment: Results of the Delphi panel

Thirteen of the 15 invited experts (87%) participated in the first Delphi round (i.e., the online survey), representing a balanced panel with expertise in health care delivery (38%), health insurance (31%) and/or health care funding (38%). In terms of background, however, community care was relatively underrepresented (23%) compared to general practice (85%) and chronic care (77%). Twelve respondents (80%) participated in rounds 2 and 3, after which consensus was reached on 12 of the 17 unique determinants identified in Dutch predictive models (see Table 3). These 12 were considered relevant for predicting future health needs on the community level (i.e. median 7–9 and IQR $\leq$ 1.5), including three predisposing, four enabling and five illness level factors (see Table 3). The highest median scores were found for the factors 'age', 'somatic illness' and 'mental illness' (median = 8), whereas the highest levels of agreement existed about 'lifestyle' and 'geography' (IQR = 0.5). The lowest median scores after three rounds were for 'household' and 'experienced health' (median = 6), whereas the least consensus existed about 'socioeconomic status' and 'prior service use' (IQR = 1.5). The factor 'housing' was considered too ambiguous by experts in terms of operationalisation and therefore excluded from the Delphi study during round 2.

Table 3
Determinants achieving consensus for relevance after three Delphi rounds.

	Median	Interquartile range
Predisposing determinants		
Age	*8*	*1*
Ethnicity	*7*	*1*
Lifestyle	*7*	*0.5*
Sex	6.5	1
Enabling determinants		
Geography	*7*	*0.5*
Income	*7*	*1*
Social network	*7*	*1*
Socioeconomic status	*7*	*1.5*
Household	6	0.5
Housing	–	–
Illness level determinants		
Somatic illness	*8*	*1*
Mental illness	*8*	*1*
Functional status	*7*	*1*
Medication use	*7*	*1*
Prior service use	*7*	*1.5*
Prior costs	6.5	1
Experienced health	6	1

4. Discussion

This paper provided a compositional overview of 10 Dutch predictive risk models for health care. Across models, a total of 17 unique determinants could be identified, 12 of which were considered relevant by experts for estimating community-level health needs for general practice, chronic care and/or community care. Two exceptions aside – i.e., sex and household – the most frequently included determinants also achieved the strongest consensus for relevance among experts. Despite differences in objectives between models, some clear compositional similarities were identified. Thus, in accordance with the Andersen and Newman framework [13], the majority of models incorporates either predisposing or enabling factors, or both; most frequently found were age and income, respectively. Moreover, illness level factors are present in most models, albeit in different forms and to varying extent. Beyond these general similarities, considerable variation exists in the specific determinants combined as well as in how they are operationalised.

Although few studies have looked at the value of predictive risk models specifically against a Triple Aim background, there is a wide array of research available on the validity of certain (combinations of) determinants for estimating future health care utilisation and costs [10,11,18,19]. Long-standing, empirically supported risk adjustment models from the US, such as the Adjusted Clinical Groups (ACG) [20], Diagnostic Cost Groups (DCG) [21] and Home Health Resource Groups (HHRG) [22] systems, show a similar reliance on illness level factors as most models included in this study, generally combining measures of disease or function with age and sex. In a comparative analysis across seven health systems, Penno et al. [12] also found a trend towards incorporating measures of disease in contemporary health care funding formulae, which the authors view as an effort to add more tangible indicators of health needs to the demographic variables that generally form the elementary starting points of such formulae. Previous research has shown that, in lieu of high-quality data reflecting absolute health needs, measures based on past resource use and/or costs – which we identified in a third of Dutch predictive risk models – are the statistically strongest indicators of future health needs [23]. However, using such measures is problematic, especially in predictive models designed for resource planning or budgeting, as it potentially rewards historic patterns of overuse, wasteful spending and excessive costs [11,20,23], as well as reinforce existing health disparities by not accounting for unmet needs [18]. Depending on the purpose for which a model is designed – generally ranging from case finding and resource allocation to performance management and evaluation [11] – the exclusion of consumption- and cost-related measures can be necessary, which reduces statistical power. More in general as well, data availability and quality issues constrain the predictive value of models, as the large amounts of routine data required are logistically difficult to obtain and inevitably less than perfectly accurate [24].

Estimating the health needs of local populations is a complex endeavour in itself, but doing so against a Triple Aim background brings forth several additional challenges. First, most existing predictive risk models, both in the Dutch health system and elsewhere, were designed specifically for application in one setting, for example in specialist care [18]. Hence, the existing evidence on their validity and reliability might not necessarily pertain to integrative initiatives executing the Triple Aim, such as ACOs and CCGs, which span the boundaries of multiple care sectors. Second, as reducing the future per capita costs of care is a vital element of any Triple Aim endeavour [5], the applicability of consumption-based health needs determinants is limited. The findings from our Delphi study illustrate this: while being among the top five most included factors across existing Dutch predictive risk models, neither 'prior service use' nor 'prior costs' achieved strong consensus for relevance among experts. Further research is necessary into potential alternatives for consumption-related determinants, which have similar predictive power but are more suitable for health needs assessment against a Triple Aim background.

Third and final, based on this study, it seems unlikely that the traditional determinants recognised in most current Dutch (and wider international) predictive risk models – that is, a combination of demographic, socio-economic and disease measures [10,11] – provide sufficient insight into community health needs to plan, design and commission sustainable, integrated care services matching those needs. After all, essential to improving population health and care experience while at the same time lowering the per capita costs (i.e., the Triple Aim) is that substitution of responsibilities occurs – as much as possible – from secondary to primary care and from primary care to community and self-care [25]. To support such substitution, a more 'holistic' approach to predictive risk modelling will likely be needed, which also takes into account broader determinants like lifestyle, health literacy, individual complexity, and social network. Insight into what the most pressing lifestyle issues are in a local population, for example, can be used to develop and offer targeted

self-management programmes, which cannot only improve people's care experience – as services are offered locally that match their needs – but may also positively affect population health and, ultimately, reduce costs by preventing future disease or exacerbation of disease [26]. With chronic conditions representing the main burden of disease today, it is perhaps not surprising that lifestyle achieved among the highest consensus for relevance in our Delphi study. However, it is not widely used (yet) in Dutch predictive risk models: only one model includes lifestyle as a factor. This might be in part due to difficulties with data collection and operationalisation, but likely also stems from the fact that the investigated models are focused mainly on primary and secondary care, while most lifestyle-related services are offered in the community [27]. Another determinant that achieved consensus for relevance among experts in this study, while being included in only one Dutch predictive risk model, is social network. Similar to lifestyle, insight into people's social network on the community level can help to stimulate substitution of professional care to informal and self-care by offering insight into how much professional care is needed beyond that which can be provided in the home situation. Although not deemed relevant by our experts, a more objective and routinely registered variable like household might serve as a useful proxy for social network in predictive risk models, as the latter is difficult to objectively operationalise on the community level.

Strengths of our study include the comprehensive overview of Dutch predictive risk models, the structured approach to extracting and classifying determinants using a well-founded theoretical framework, and the balanced Delphi panel used to assess determinant relevance. However, there are also some limitations. Most notably, testing the internal validity of the identified determinants – either individually or in different combinations – for estimating population health needs on quantitative population data was beyond the scope of the research. Although the study's primary aim was to create a compositional overview of Dutch predictive risk models and experts were brought in to rate the relevance of extracted determinants (face validity), this means findings must be interpreted with caution. Another limitation was our approach for model identification, which was based on a combination of web research and input from relevant professional bodies. While this may have induced some selection bias, we believe the involvement of a broad range of perspectives – i.e., health care practitioners, policymakers and payers – resulted in an overview that adequately reflects the range of prediction models in relevant Dutch health system sectors.

5. Conclusions

When combining the right determinants, predictive risk models can support providers and commissioners in balancing population needs with available resources and interventions, as well as proactively targeting those most at risk in their communities. Further research is needed to test the validity and reliability of existing predictive risk models in community-based, integrated care settings as well as to develop and include additional determinants more befitting the Triple Aim. For some less tangible determinants, such as social network, a routinely registered variable like household type might serve as a sufficient proxy, offering insight into how much professional care is needed beyond what can be provided in the home situation. In general, however, data availability and quality issues will likely form a major barrier to designing predictive models that effectively support community-based care initiatives working towards the Triple Aim. Policymaking efforts may be needed to tackle privacy concerns and database compatibility problems, and in so doing push the process of linking pseudonymous datasets from health and social care providers, municipalities, national (health) surveys, research institutes and other relevant bodies. Without such data integration, it seems unlikely that provider networks in countries around the world can gain sufficient insight into their communities' genuine health needs to effectively and sustainably meet them.

Conflict of interest statement

None of the authors have any conflicting interests to declare.

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