

Sociological theory and intervention in Public Health. A study on vaccine hesitancy

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This study deals with the design and implementation of public health interventions in relation to vaccine hesitancy. The main objective, based on a literature review (LR), is to find answers to two questions regarding public health interventions: a) the usefulness of theory for the design of public health interventions and b) the applicability of theory to interventions. Therefore, the study examines theoretical approaches, context and complexity of interventions; discusses specific theories such as Actor-Network Theory, Social Worlds Theory and Normalisation Process Theory and argues the application of theories to established intervention models.

Parole chiave: Sociological Theory; Healthcare professional Training; Actor-Network Theory; Social Worlds Theory; Vaccine hesitancy; Public Health Intervention.

Teoria sociologica e intervento nella sanità pubblica. Uno studio sull'esitazione vaccinale

Questo studio tratta la progettazione e l'implementazione di interventi di sanità pubblica in relazione all'esitazione vaccinale. L'obiettivo principale, basato su una revisione della letteratura (LR), è trovare risposte a due questioni riguardanti gli interventi di sanità pubblica: a) l'utilità della teoria per la progettazione di interventi di sanità pubblica e b) l'applicabilità della teoria agli interventi. Pertanto, lo studio esamina approcci teorici, contesto e complessità degli interventi; discute teorie specifiche come la "Actor-Network Theory", la "Social Worlds Theory" e la "Normalisation Process Theory" e argomenta l'applicazione delle teorie a modelli di intervento consolidati.

Keywords: Teoria sociologica; formazione dei professionisti della sanità; Actor-Network Theory; Social Worlds Theory; Esitazione al vaccino; Intervento di sanità pubblica.

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1. Introduction: theory, context, complexity

Studies show that effective planning links sociological theory to public health intervention and is functional to ‘justify’ the rational choice concerning the purpose (Hilário et al., 2023). An adequate theoretical framework is helpful to remove barriers to innovative educational intervention for healthcare professionals (Lo Moro et al., 2023).

There is growing interest in using cognitive, behavioural, and organisational theories to understand barriers to implementation, to inform the design of interventions to improve professional practice and to explore the mediating mechanisms and potential moderators of such interventions in the context of rigorous evaluations. However, Davis et al. (2010) argues that the extent to which theory has been used in implementation research needs to be clarified. To address this issue, they systematically reviewed the use of theory in designing interventions and interpreting their controlled evaluations.

This systematic review reveals a significant lack of theory in the design and implementation of PH interventions, at least until 1998. The authors also recommend that how it is proposed to explain what it was applied to, as well as the methodological details of how the theory was analysed and operationalised, should be clearly stated (Davis et al., 2010).

1.1. Theoretical approaches

In this section, we try to prove the importance of connecting to theories with intervention. According to Nielsen (2015), theoretical approaches used in implementation science have three general objectives: to describe and/or guide the process of translating research into practice (process models); to understand and/or explain what influences implementation outcomes (determinant frameworks, classical theories, implementation theories); and to evaluate implementation.

As we have already mentioned, the review of implementation strategies by Davies et al. (2010) showed that only 10% of the identified studies provided an explicit rationale for their strategy. The mixed results of Evidence-Based Practice (EBP) implementation in various contexts have often been attributed to a limited theoretical basis. As Nielsen (2015) argues, a poor theoretical basis makes it difficult to understand and explain how and why the intervention succeeds or fails, thus limiting opportunities to identify factors that predict the likelihood of successful implementation and to develop

better strategies to achieve more effective implementation. Implementation studies now apply theories borrowed from disciplines such as psychology, sociology, and organisational theory, as well as theories, models and frameworks that have emerged from within implementation science.

It is necessary to distinguish between theories, models, and frameworks since a theory can be defined as a set of analytical principles or statements designed to structure observation, understanding and explanation of the world. For instance, a ‘good theory’ explains how and why specific relationships lead to events. Models are, however, closely related to theory, and the difference between a theory and a model is only sometimes clear as they can be described as theories with a narrower scope of explanation. The main difference is that a model is descriptive, whereas a theory is explanatory and descriptive. On the other hand, frameworks do not provide explanations; they describe empirical phenomena by placing them in categories (Nielsen, 2015). Implementation should, therefore, be seen as a multidimensional phenomenon with multiple interacting influences (Gurses et al., 2010).

The determinant frameworks in implementation science suggest that different theories are relevant to understanding and exploring the many influences on implementation. Using a single theory that focuses only on a particular implementation aspect will only tell part of the story. For example, we can ask the following questions: are people primarily driven by their individual beliefs and motivations, or does a pervasive organisational culture impose norms and values that govern how people behave? Do reflexive thought processes mainly influence a specific behaviour, or is it a habit automatically enacted? (Nielsen, 2015). This means that different approaches may require different methods based on epistemological and ontological assumptions.

Although Nielsen (2015) maintains the importance of theories as they provide individual facts with a meaningful context and contribute to constructing an integrated body of knowledge, he warns about the controversial aspects of using theory as it can serve as a blinker, causing us to ignore problems that do not fit into existing theories, models and frameworks or preventing us from seeing known issues in new ways. Theorising about implementation should, therefore, not be an abstract academic exercise disconnected from the real world of implementation practice. However, the inductive construction of theory and its deductive application is necessary.

1.2. Context and Change Theories

Context is integral to all determinant frameworks. Described as “an important but poorly understood mediator of change and innovation in healthcare organisations”, context lacks a unifying definition in implementation science and related fields such as organisational behaviour and quality improvement (Nielsen, 2015: 5). The role offered to context varies, from studies that see it in terms of a “physical environment or setting in which the proposed change is to be implemented” to analyses that assume the context as something more active and dynamic that influences the implementation process and its outcomes. The vital importance of context in intervention research was perhaps most convincingly articulated almost 20 years ago by Pawson and Tilley (1997), who argued that mechanisms of change are always contingent on context; what ‘works’ in one time and place may be ineffective, or even harmful, elsewhere. However, population health science has been slower to respond to the importance of understanding context than understanding mechanisms (Moore, Evans, 2017). To illustrate their point, Moore and Evans take the changing context of tobacco use in each population as an example. Within this much-changed macro-system, there is a need to revisit assumptions about the mechanisms through which youth smoking is sustained and how it might be changed. One must always consider the contingency of mechanisms in time and space and be grounded in a contextually appropriate theory of how the problem is maintained.

Emerging methodological work published by the National Institute for Health Research invites researchers to take a closer look at context issues (Howarth et al., 2016). Interventions are attempts to disrupt the mechanisms that perpetuate and sustain a problem in each time and place. Therefore, they cannot be described nor understood if they are isolated from the systems they attempt to change. It deals with a paradigm shifts from the traditional approaches (Moore, Evans, 2017). Then, we can define context as a set of characteristics and circumstances that consist of active and unique factors surrounding the implementation effort; it is versatile, including setting, roles, interactions, and relationships (Minary et al., 2018). In this regard, Rod et al. (2014) points out that effective public health interventions reconfigure social relations as they change the context, which in turn transforms the intervention. Accordingly, the authors proposed the concept of ‘intervention spirit’ to define the dimensions of an intervention that make it socially effective.

1.3. Complex Interventions in Complex Context

It must be considered that public health interventions in the form of policies and programmes are designed to change the distribution of health determinants in a population. Shiell et al. (2008) proposed a systems approach to deal with the complexity of such interventions in correlation with the different contexts in which the intervention is carried out. According to them, an intervention can be represented as a series of interconnected events that occur within a more extensive system with which they are in constant interaction. The effects of the intervention are thus modulated, mitigated, or amplified by the characteristics and dynamic evolution of the context in which it is implemented. This is why interventions are adaptive, i.e., they evolve because of transformations in the context (Minary et al., 2018).

Considering the adaptive and interactive dimensions of interventions in the context, literature invites us to understand the whole system instead of breaking it down into its components. Some authors use the network metaphor to define an intervention as a system. An intervention might be considered a time-limited series of events, new activity settings and technologies that can transform the system because of their interaction with the context and its capacity.

In their adaptation of Actor-Network Theory, Bilodeau and Potvin (2016) explained why interventions can be conceived as socio-technical networks in which the differentiation between human and non-human, social and technical and individual and collective is irrelevant. This approach focuses on the connections between the various entities that make up the intervention and its context, their mutual influence, and the evolution of the network they form. It is, therefore, essential to distinguish the entities specific to the intervention from those linked to its context.

2. Analysing theories

Based on the theories considered, we assume that some theories may be significant for the support of complex interventions in public health, such as Actor-Network Theory (ANT), Social Worlds Theory (SWT) and Normalisation Process Theory (NPT). Table 1 and the following extended analysis highlight that they come from different disciplinary backgrounds and have different key characteristics, although some concepts and analyses are common. Therefore, NPT is recognised in implementation science, while ANT comes from the social sciences and STS (Science and Technology Studies)

and is tested as an implementation theory. SWT also comes from the social sciences and STS, and it is considered a theory/method package useful in empirical science, technology and medicine projects and interventions.

Table 1 – Summary of the three theoretical approaches considered.

Theoretical approach	ANT	SWF	NPT
Original developers, years of key developments	Latour, Callon 1980s onwards	Clarke, Star, Mead 1960s onwards	Murray et al. 2000s onwards
Disciplinary origins	Social sciences, science and technology studies	Social sciences, science and technology studies	Implementation science
Key characteristics important for complex health interventions	(1) Deals with systems made up of human and non-human entities and proposes a relational view of the action. (2) Provides an understanding of intervention-context interactions, and (3) it is a tool to open the ‘black box’ of intervention.	(1) Social worlds are shared and deeply relational discursive spaces, with emphasis on the inter-institutional mechanisms through which people organise social life. (2) The concept of the Theory-Method Package focuses on the integral aspects of ontology and epistemology, theory and practice. Theory, methods and intervention are in continuous interaction with each other.	(1) Addresses the factors necessary for the successful implementation and integration of interventions into routine work (normalisation). (2) Healthcare is a collective activity requiring many interactions between professionals, patients, managers and others.
Core concepts	Action, relation, social interaction, translation, networks of actors, translation, controversy.	Social worlds, situational analysis, arena, infrastructure.	Coherence (or sense-making); cognitive participation (or involvement); collective action (work done to enable the intervention); and reflective monitoring (formal and informal)

			evaluation of the benefits and costs of the intervention).
Core arguments	1. Conceptualization of context about networks of actors and their actions by identifying the various relevant components in a situation (social actors, physical objects, symbolic objects), analysing their attributes, strategic positions, and power relations. 2. A process of connections and translations (problematization, interessement, enrolment, and mobilisation) that produces change, which, in turn, needs interaction, negotiation, and closure of controversies.	1. Beginning of research is not approached with a kind of <i>tabula rasa</i> but with a baggage of existing traditions, hypotheses, theories and resources that serve as primary metaphors applicable to the investigation situation.	1. Focuses on the work that individuals and groups do to enable an intervention to normalise. 2. Interventions' components are not linear but are in dynamic relationships with each other and with the broader context of the intervention, such as the organisational context, structures, social norms, group processes and conventions.

2.1. The Actor-Network Theory

ANT has been developed by Bruno Latour, Michel Callon and others since 1980. Originally, ANT was developed in the sociology of science, focusing on understanding the production of scientific facts and technology (Esposito, Petroccia, 2023). As this theory developed a renewed social worldview, it evolved into a major sociological theory known as the *sociology of translation* (Volonté, 2017).

ANT is now recognised as a useful conceptual tool for assessing complex situations and analysing the production of change in complex systems such as health care; it offers a powerful tool for opening the 'black box' of public health interventions as it provides a means of mapping the genesis of interventions in the form of a networking process (Bilodeau, Potvin, 2018; Potvin, Clavier, 2013; Bisset, Potvin, 2007;).

Three arguments support the relevance of using ANT to analyse PHI as a process of social change:

1. ANT suggests a relational view of the action.
2. Conceives the context as defined by actors and their actions.
3. Allows the investigation of how effects are produced.

ANT shows that it is not the actors *per se* who constitute the focus of the analysis but rather the connections between them through which they act. Interventions are thus seen as systems of action in the form of networks (Latour, 2005). In this regard, it is worth mentioning the *connectionist paradigm*, a complex of theories and transdisciplinary approaches that seeks to seriously confront the problem of the complexity of the physical world, the living world, and the social world, overcoming the mechanism paradigm that separates nature from culture, mind from body (Giarelli, Venneri, 2009).

ANT also promotes the conceptualisation of context in relation to networks of actors and their actions by identifying the various relevant components in a situation (social actors, physical objects, symbolic objects), analysing their attributes, strategic positions, and power relations. It must therefore be taken into account that all interactions are situated; that is, they take place in a specific area and have a specific temporal duration (working, meeting friends, having dinner with the family, going to the cinema, etc.) so when analysing the contexts in which social interaction takes place, it is useful to study the movements of individuals in space and time. Scholars speak of ‘space-time convergence’ to analyse how social development and technological change affect social life patterns by producing a radical reorganisation, affecting everyone’s existence.

Another interesting concept of ANT is “translation”, a process of connections and translations (problematization, *interesement*, enrolment, and mobilisation) that produces change, which, in turn, needs interaction, negotiation, and closure of controversies. The notion of *controversy* is central to the process of translation. Controversies are resolved through translation with the addition of knowledge, other points of view and argumentative elements, as well as with the strengthening of existing connections and the enrolment of new relevant actors who bring new knowledge and resources necessary for action (Potvin, Clavier, 2013).

2.2. The Social Worlds Framework: A Theory/Methods Package

The SWT is situated in the American sociological tradition of symbolic interactionism and has its roots in the Chicago School of Sociology. As

Clarke and Star (2008) explain, the structure of social worlds is the conceptual infrastructure of situational analysis. At the same time, infrastructures (virtual, offline, textual, and technical) are entwined with the nature of each social world and, when scale becomes essential, with arenas. Multiple social worlds, ecologically organised around issues of mutual interest and aimed at action, make up an arena. Social worlds are, therefore, universes of discourse (Mead, [1938]1972), shared and deeply relational discursive spaces, i.e. the main inter-institutional mechanisms through which people organise social life (Clarke, Star, 2008).

People generally participate in several social worlds simultaneously, and this participation remains highly fluid, although it must always be taken into account that the individual actors make up social worlds. In the arenas, they represent their social worlds, interpreting their collective identities (Klapp, 1972).

Situational analysis, from which SWT is inspired, is an example of a tradition-based construction of social worlds and arenas as a theory/methods package suitable for a new analysis method. The SWT framework seeks to examine all the human and non-human actors and elements contained in a situation from each one's perspective; it attempts to analyse the various types of work involved in the creation and use of science, technology and biomedicine, clarifying multiple levels of meaning of the group involved, engagements and material practices.

Clarke and Star explain that «In situational analysis, the conditions of the situation are in the situation. There is no such thing as 'context.' The conditional elements of the situation need to be specified in the analysis of the situation itself as they are constitutive of it, not merely surrounding it or framing it or contributing to it. They are it. Ultimately, what structures and conditions any situation is an empirical question or set of analytic questions» (2008: 128).

In the social sciences, it is argued that the nature of perception is theory-driven and socially grounded, which means that the beginning of research is not approached with a kind of *tabula rasa* but with a baggage of existing traditions, hypotheses, theories, and resources that serve as primary metaphors, applicable to the situation of investigation. The concept of the theory-methods package, as outlined by Clarke and Star (2008), focuses on the integral aspects of ontology and epistemology. It assumes that ontology and epistemology are both co-constitutive (mutually composable) and manifest in actual practices. It is an abductive approach in which the researcher moves back and forth between empirical materials and the conceptual means to express them.

The theory/methods package seems interesting for our analysis as it assumes that method and intervention are not at the service of theory. However, that theory, methods, and intervention are in continuous interaction with each other and that the structure of social worlds is itself a theory/methods package. In this sense, we can consider it an applied theory, applicable to interventions in complex systems such as public health. The framework of social worlds as a theory/method package can thus be useful in pragmatic empirical science, technology and medicine projects and interventions, as is shown by several types of research in medical and biomedical fields (i.e. Fujimura, Fortun, 1996; Clarke, Casper, 1996).

2.3. *Normalisation Process Theory*

The Normalisation Process Theory (NPT) addresses the factors necessary for the successful implementation and integration of interventions into routine work (normalisation) (Murray et al., 2010). The NPT can be used as an awareness-raising tool. It is a new theory that offers researchers a coherent framework that describes, evaluates, and improves the potential for implementation. NPT challenges theories and processes of normalisation and standardisation because they need to capture the complexity of events and interventions and are, therefore, ineffective. NPT recognises that healthcare is a collective activity requiring many interactions between professionals, patients, managers, and others. An intervention that appears to affect only one individual or group may, on closer examination, involve a chain of successful interactions. *Understanding, developing and evaluating* complex interventions is essential for improving health and healthcare, so much so that the Medical Research Council has published its influential framework for the development and evaluation of interventions that “are built from several components, which may act both independently and interdependently” (MRC, 2000), emphasising that the early stages of a study should be considered *iterative* rather than *linear*; that both intervention development and evaluation require a sound theoretical basis; that detailed descriptions of the intervention and evaluation context are necessary; that modelling to estimate potential benefits is important before proceeding to a trial, and that qualitative methods can help to understand the processes involved in intervention and evaluation.

NPT focuses on the work that individuals and groups do to enable an intervention to normalise, including four main components of NPT: coherence (or sense-making); cognitive participation (or involvement); collective

action (work done to enable the intervention); and reflective monitoring (formal and informal evaluation of the benefits and costs of the intervention). These components are not linear but are in dynamic relationships with each other and with the broader context of the intervention, such as the organisational context, structures, social norms, group processes and conventions (Murray et al., 2010).

However, effective intervention is in an experimental setting; its long-term impact depends both on its effectiveness in the ‘real world’ and on how widely it is implemented. Therefore, it is also necessary to consider implementation problems by considering the context in which the intervention will be implemented and how any changes may affect the planned intervention. NPT provides a framework for mapping important elements of context. NPT can also be used to drive the evaluation design of a complex intervention, considering that the context of the evaluation is as essential as the context of the intervention. This requires consideration of the identification of the systems already in place and how well the proposed test procedures fit these systems and it is essential to think about the impact of the trial procedures on the work of all the people involved in the trial, including healthcare professionals, patients, and support staff.

In conclusion, the authors argue (Murray et al., 2010) that NPT is a new theory that offers researchers something that has been lacking so far, namely a coherent framework that can be used to describe and judge the potential for implementation but also, more importantly, to design and improve complex interventions. NPT seems to have a sound theoretical and methodological framework that deserves consideration in the study of complex interventions in public health.

3. Connecting theories, models, and interventions

This third part of the article, as already mentioned, aims to link theories (ANT, SWT, NPT) with intervention models, answering two basic questions.

- What is the usefulness of these theories?
- How can they be applied to interventions?

To answer these questions, we try to connect the theories to intervention by taking two examples: the *Six steps in quality intervention development* (6SQuiD) framework and the *Template for Intervention Description and Replication* (TIDieR checklist). The choice to link theories to interventions was on these two models because they are internationally recognised, tested, and

applied as effective intervention models in public health (Hoffman et al., 2014; Wight et al., 2016; Pringle et al., 2018), as outlined below.

3.1. Connecting theories and 6SQuID framework.

The 6SQuID framework provides a useful model for determining how to develop interventions to maximise their effectiveness in the PH field to change individual and collective attitudes and culture regarding health issues (e.g. smoking, alcohol use, vaccine hesitancy, etc.) also implying the specific socio-cultural contexts involved. The six steps detail a process that ensures due reflection on the initial problems, understanding the health problems and their context, and those factors that have the greatest scope for change. 6SQuID builds on existing intervention development frameworks, including the UK Medical Research Council's guidelines for the development and evaluation of complex interventions, providing a series of pragmatic steps. The framework is consistent with international guidelines on the contribution that appropriate implementation can make to maximising the positive impact of health interventions (Wight et al., 2016). Therefore, considering Table 1, we can identify some theoretical issues discussed above.

Table 1 – 6SQuID process

6SQuID	Details
Step 1: define and understand the problem	Clarify the problem, using the existing research. Establish how the issues are socially and spatially situated, including any immediate or underlying influences.
Step 2: clarify which causal or contextual factors are malleable and have greatest scope for change	Identify the factors that shape the problem and have the greatest scope to be changed. Diagrammatic representation in step 1 may help to establish the most effective intervention point(s) in causal pathways
Step 3: identify how to bring about change: the change mechanism	Articulate the theory of change and mechanism(s) for incorporation into intervention
Step 4: identify how to deliver the change mechanism	Investigate the means and options for delivering the intervention, as well as target groups and context
Step 5: test and refine on a small scale	Identify a means of testing the intervention in an appropriate setting, for a small sample of the target group(s), as detailed in step 4
Step 6: collect sufficient evidence of effectiveness to justify rigorous implementation or evaluation	Gather evidence that the intervention has worked as intended in the small-scale application. This may include critically examining any unintended/detrimental effects

Source: Adapted from Pringle J., et al. (2018), Adolescents and health-related behaviour: using a framework to develop interventions to support positive behaviours. *Pilot Feasibility Studies*; 4:69.

The definition and understanding of the problem (step 1) bring us directly to SWT frame, which explains the nature of perception as theory-driven and socially grounded. This means that the beginning of the research should not be treated as a *tabula rasa* but reference should be made to the already existing stock of traditions, assumptions, theories and resources. Situational analysis (quoted in both ANT and SWT) establishes how the topics of intervention are socially situated, i.e., in space and time, as well as interactions (human and non-human).

Steps 2, 3 and 4 of the 6SquID framework focus on change and the factors that can produce change (mechanisms). Social change is one of the main objects of study in sociology, even if it is declined through different approaches. Here we can refer to what produces a change in public health. According to ANT, change occurs through *translation*: a process of connections and translations (problematization, *interessement*, enrolment, mobilisation) that produces change that, in turn, needs interaction, negotiation, and closure of controversies.

Another recurring theme in the theories is context (step 4). ANT theory promotes the conceptualisation of context in relation to networks of actors and their actions by identifying the various relevant components in a situation and analysing their attributes, strategic positions, and power relationships. SWT goes beyond the ‘context’ since, in situational analysis, the conditions of the situation are in the situation.

The topic of intervention evaluation (steps 5 and 6) is mainly considered by the NPT. In the NPT it is argued that understanding, developing, and evaluating complex interventions is essential for improving health and healthcare, emphasising that the early stages of a study should be considered *iterative* rather than *linear*.

Steps 5 and 6 indicate both small and large-scale evaluations of the intervention. In the theories discussed, we did not find specific subjects on evaluation methodologies, but we know that social research is full of them. This is not the appropriate context in which we must deal with evaluation methodologies. Instead, we can turn once again to the ANT, which in explaining the process of *translation* highlights the steps of change on a small and large scale. The process of translation (movement/transfer/change) consists of four non-linear steps: *problematization*, which involves the identification and connection of entities that are relevant to the situation at hand; *interessement*,

which is the development of conversation in a network through the negotiation of roles and interests; *enrolment*, which is the product of successful interest resulting from negotiation between the parties. The last step is *mobilisation*, which consists of reaching a mass of connected actors capable of coordinating their actions, thus testing the strength of these connections. So, in this transition from the first four stages of translation to mobilisation, we can interpret intervention, first on a small scale and after on a large scale (mobilisation). An evaluation plan can be built on these assumptions.

The notion of controversy is central to the process of translation: controversies combine and interweave the techno-scientific and political contents that make up the issues that the actors (health professionals, parents, social contexts, technology, etc.) must deal with. Controversies, therefore, are solved through translation by adding knowledge, other points of view and argumentative elements, as well as by strengthening existing connections and recruiting new relevant actors who bring new knowledge and resources.

3.2 Applying theories to TIDieR Checklist

When designing a public health intervention, it's crucial to detail all elements for assessing effectiveness and estimating its effect. Key characteristics like duration, intensity, delivery mode, processes, and monitoring can influence effectiveness and reproducibility. The TIDieR checklist, developed by international experts, is recommended for local intervention planning and evaluation study designs (table no. 2).

Table 2 – TIDieR Checklist

TIDieR	Details
Item 1. Short name	Describe the health intervention with a name or a sentence.
Item 2. Why	Describe any possible rationale, theory, or objective of the essential elements of the health intervention.
Item 3. What (materials):	Describe physical materials and information/communication tools used in the intervention, including those provided to participants or used in the delivery of the intervention or in the training of the deliverer.
Item 4. What (procedures)	Describe all procedures, activities and/or processes used in delivering the intervention, including any preparatory or support activities.
Item 5. Who provided	Describe the background, expertise and specific training for each professional category involved in providing the intervention.

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Item 6. How	Describe how the intervention is delivered (e.g., in-person or other modalities such as Internet or telephone) and whether it is delivered individually or in groups.
Item 7. Where	Describe the type(s) of place(s) where the intervention is delivered, including any necessary infrastructure or relevant requirements.
Item 8. When and how much	When and how much: Report how many times the intervention is delivered and in what period, including the number of sessions and their time schedule, duration, intensity.
Item 9. Tailoring	the intervention is planned to be tailored, so describe what, why, when, and how.
Item 10. Modifications	If some changes happen in the plan or during the implementation, describe the changes (what, why, when and how).
Item 11. How well (planned)	If adherence and fidelity to the intervention were assessed, describe how and by whom and any strategies used to maintain or improve adherence.
Item 12. How well (provided)	If adherence and fidelity to the intervention were assessed, describe the extent to which the intervention was delivered as planned.

Source: adapted from Hoffmann T.C. et al., 2014). Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ: 348.

The checklist for the design of the Horizon project (anonymised) on vaccine hesitancy focuses on several key theories. It includes items 1 and 2 (name and why), which require identifying the type of intervention (NPT), the connection with other studies (SWT), and providing useful information to identify mediators for improving knowledge, increasing trust between practitioners and patients, and producing change in behavior and attitudes (ANT). Item 3 (what materials) refers to the ANT theory, which considers non-human resources as determining and interacting with human resources. Item 4 (what procedure) is related to the notion of an ‘interventional system’ as a set of interconnected humans and non-human contextual agents within spatial and temporal boundaries that generate mechanistic configurations (mechanisms) that are prerequisites for change in health (SWT and ANT). Item 5 (who provided) requires the description of the background, expertise, and specific training for each professional category involved in the intervention, which can be linked to the topic of context and Social Worlds. Item 6 (how) is related to the SWT, asking about the training methods adopted for the intervention, whether it is delivered individually or in groups, and why one method is chosen over another.

Items 7 and 8 (where, when, and how much) require identifying and describing the context (also the physical one) where the action takes place and

why one option or another is chosen. Also, in these items, we find adherence to both SWT and ANT as well as NPT, which focus on the importance of context and its interconnections. Item 9 (tailoring) recommends planning a tailored intervention focusing on *what*, *why*, *when* and *how*. In tailored interventions, not all participants or groups of participants receive the same intervention; it depends on the target group being trained. Tailored intervention refers back to NPT, which addresses the factors necessary to successfully implement and integrate interventions into work routines (normalisation).

Item 10 (modifications) considers that unforeseen changes could happen in the plan or during the implementation of the intervention, so it is necessary to describe the changes (what, why, when and how) that occurred and how they were approached and overcome (SWT). Items 11 and 12 (How well, planned and provided) focus on adherence and fidelity to the intervention, requiring describing how and by whom and any strategies used to maintain or improve adherence. The evaluation of the intervention is beneficial in responding to these two items. NPT considers the evaluation as essential as the intervention.

Conclusions

This study explores the effectiveness of theory in complex public health interventions. It explores various theories, including sociological, science and technology studies, and implementation science, to understand the interaction between theory and practice. Critical concepts such as context, complexity, interconnection mechanisms, non-standardization, and the social worlds of health workers, trainers, and patients were identified. The study links the theories to two public health intervention models to demonstrate their relevance.

The analysis of ANT, SWT and NPT and connection with two significant PH intervention models (6SQuiD and TIDieR) highlights the relationship between theories and interventions and the applicability of theories to intervention methods. Furthermore, this study shows that several theories can be applied to one intervention, and different models can refer to the same theories, confirming both the complexity of interventions in PH and the interaction between the elements.

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Finally, the interventions piloted by the Horizon project partners, using a complex approach between theories and intervention models, achieved good results in changing the knowledge and behaviour of the HCPs who attended the educational pathways. The lessons learned also provide valuable insights into what works and what needs to be improved to raise awareness of the complexity of vaccine hesitancy among health professionals.

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