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[OAMJMS] Submission Acknowledgement

Prof. Dr Mirko Spiroski via SFS - Journals (Scientific Foundation SPIROSKI - Journals), Skopje, Republic of Macedonia <noreply@publicknowledgeproject.org>

Sat, Mar 12,
2022 at 3:38 PM

Reply-To: "Prof. Dr Mirko Spiroski" <mspiroski@yahoo.com>

To: Arief Hargono <arief.hargono@fkm.unair.ac.id>

Arief Hargono:

Thank you for submitting the manuscript, "Analysis of integrated information systems in community-based and school-based public health surveillance " to Open Access Macedonian Journal of Medical Sciences. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Submission URL: <https://oamjms.eu/index.php/mjms/authorDashboard/submission/9346>

Username: ariefhargono

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Prof. Dr Mirko Spiroski



Arief Hargono <arief.hargono@fkm.unair.ac.id>

[OAMJMS] Editor Decision

Katerina Spiroska via SFS - Journals (Scientific Foundation SPIROSKI - Journals), Skopje, Republic of Macedonia <noreply@publicknowledgeproject.org>Mon, Mar 28,
2022 at 5:27 PM

Reply-To: Katerina Spiroska <kspiroska07@gmail.com>

To: Arief Hargono <arief.hargono@fkm.unair.ac.id>, Kurnia Dwi Artanti <kurnia-d-a@fkm.unair.ac.id>, Fariani Syahrul <fariani.s@fkm.unair.ac.id>, Evi Lioni <evi.lioni-2017@fkm.unair.ac.id>

Arief Hargono, Kurnia Dwi Artanti, Fariani Syahrul, Evi Lioni (Author):

We have reached a decision regarding your submission to Open Access Macedonian Journal of Medical Sciences, "Analysis of integrated information systems in community-based and school-based public health surveillance", Manuscript ID = OJS9346.

Our decision is: Revise your manuscript until May 02, 2022 and submit on the OAMJMS website.

Sincerely,
Prof. Dr Mirko Spiroski,
Editor-in-Chief, OAMJMS

Reviewer C:
Recommendation: Revisions Required

Comments to the Author

Minor Revision

**C-submit-12.03.docx**

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1 **Analysis of integrated information systems in**
2 **community-based and school-based public health surveillance**
3

4 **Abstract**

5 The involvement of the community in supporting health programs requires an integrated
6 information system. Public health registers obtained by the community means some data is
7 collected repeatedly in different formats or leads to data redundancy. This research aims to
8 analyze and design an integrated information system model of current community-based and
9 school-based public health surveillance based on a system development life cycle (SDLC)
10 approach. Data analysis is carried out using content analysis. The results show that entities
11 involved in the system include health cadres in *Posyandu* (an integrated health post for
12 maternal and child health), *Posbindu* (an integrated development post of non-communicable
13 disease), and school health services. The necessary data include data on vital characteristics,
14 maternal and child health, the risk factors of both communicable and non-communicable
15 diseases, students' illness complaints, clean and healthy living behavior, mortality, and
16 environmental health. Information obtained includes the health status of an individual,
17 planning on pregnancy and labor, antenatal care visits, stunting data, immunization status,
18 students' illness complaints, the number of accidents, larva-free rate, and mortality rate.
19 Information from the system is reported to public health centers, the district health office, and
20 district education office. The output of the system is useful to complement the recording and
21 reporting of data from health facilities.

22 **Keywords:** integration, health system, community-based, school-based, surveillance

23 Introduction

24 Indonesia is struggling to face the triple burden of disease as a result of the increasing
25 prevalence of non-communicable diseases (e.g., diabetes, hypertension, and stroke) and
26 incidences of re-emerging and new-emerging diseases (e.g., SARS, avian influenza, and swine
27 influenza) while the infectious diseases (e.g., tuberculosis and HIV/AIDS) are still on the rise
28 (1). To respond to this challenge, the government of Indonesia has initiated the involvement of
29 health information systems. However, these systems remain disease-specific, fragmented, and
30 unconsolidated. For example, the HIV and AIDS information system (SIHA) was implemented
31 to integrate a HIV and AIDS recording and reporting system (2), the integrated tuberculosis
32 information system (SITT) (3), and registers for maternal and child health (4).

Commented [sh1]: mention the year and the number detected !

33 Health surveillance is defined as a continuous, systematic collection, analysis, and
34 interpretation of health-related data that are essential to the planning, implementation, and
35 evaluation of health practice. Health surveillance plays an important role in providing evidence
36 to facilitate the prevention and control of diseases (5). Health surveillance is one of the
37 subsystems in the national health system of Indonesia that is regulated by the Presidential
38 Regulation of the Republic of Indonesia Number 72 of the year 2012 on the National Health
39 System. As one of the data sources that can be conducted through both active and passive
40 surveillance, the involvement of community members is important to improve data quality.

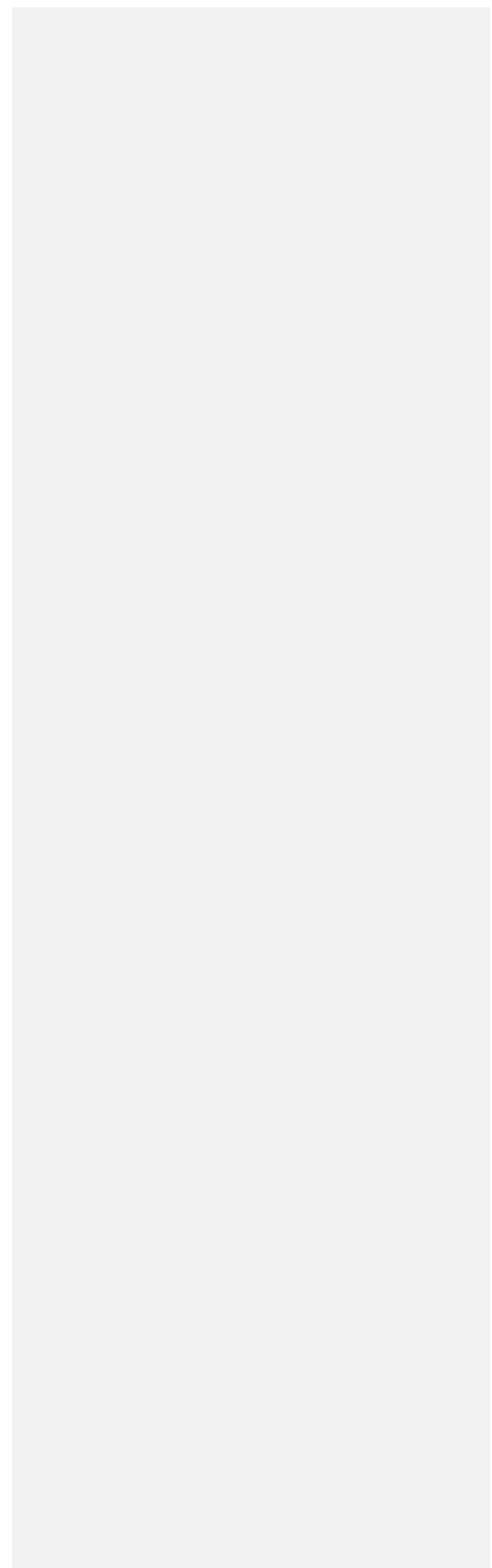
41 The involvement of the community in health surveillance is reflected by the role of health
42 cadres through *Posyandu* (an integrated health post for maternal and child health), *Posbindu*
43 (an integrated development post of non-communicable disease), and school health services.
44 Health programs carried out by the community are expected to be comprehensive and
45 continuous in accordance with the continuum of care. The continuum of care is a strategic
46 approach in looking at health problems in a comprehensive range from the birth to death of an
47 individual (6). This approach helps healthcare providers meet the needs of an individual
48 through life's transition considering that the individual may be more vulnerable and susceptible
49 to health problems during discontinuities or gaps in care (7). For instance, it is evidenced by
50 (8) that maternal health status can be used as a risk factor predictor for the mother and the baby
51 she conceived and bore. This confirms that the relationships between mothers and babies
52 cannot be separated in terms of the need for health services.

53 One of the efforts that can be made to effectively sustain the health programs is to
54 integrate the program. Integration refers to the act of adoption or assimilation of smaller health
55 interventions into a single health system that functions as one (Atun, 2009). Suter et al. (2009)
56 stated that information systems are one of the key principles in the success of integrated health
57 systems. Information system integration can be carried out through developing current
58 information systems in the context of data management and usage. An integrated information
59 system connects users, providers, and various parties related to their health problems. This
60 study aims to develop an integrated information system model of school-based and community-
61 based public health surveillance.

62 Design and Methods

63 The result of this study is part of a multiyear sequencing study that was conducted from
64 February 2018 to November 2020 through the integration of recording and reporting systems
65 in community-based and school-based surveillance. The conceptual framework is based on
66 the continuum of care approach (9) and the system approach (6). Continuum of care refers to

67 the continuity of care from the birth to death of an individual. The research conceptual
68 framework is presented in Figure 1.



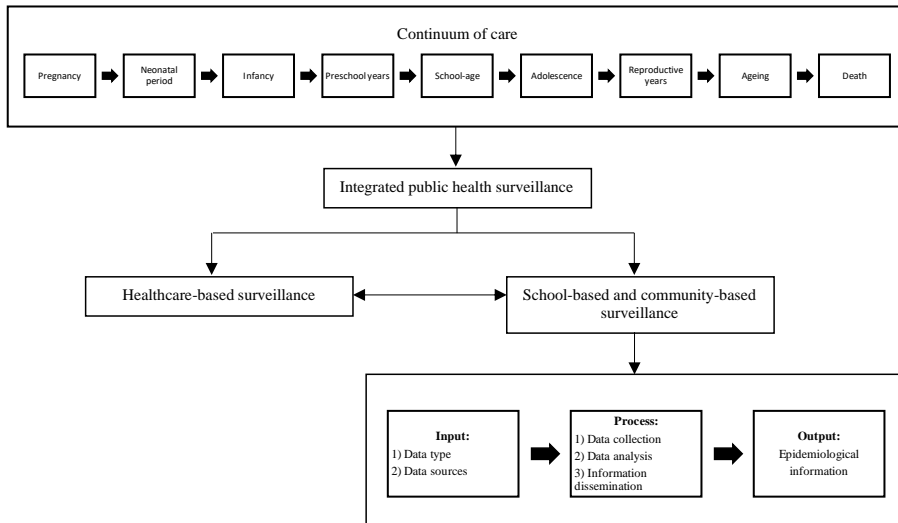


Figure 1. Conceptual framework

This research is operational research in developing current health information systems with variables including data types, data sources, data collection, data analysis, information dissemination, and epidemiological information based on a system development life cycle (SDLC) approach. This approach includes system analysis, system design, system implementation, system maintenance and monitoring, and evaluation. The SDLC stages performed in this study were system analysis and design as part of a system approach. The system analysis stage describes the ongoing surveillance information system based on system components, namely input, process, and output. This stage also identifies the data and information required by the integrated surveillance information system. Furthermore, the system design stage is carried out by developing an application prototype based on data flow diagrams (DFD).

The city of Surabaya was chosen to be the research location due to the high prevalence of health problems that occurred. The research information is obtained from surveillance staff at the Surabaya City Health Office, school healthcare unit providers, and health cadres in *Posyandu* and *Posbindu*. Data collection is carried out by in-depth interviews, documentary studies, and focus group discussions. The documentary studies are conducted on the recording and reporting formats used in the ongoing school-based and community-based surveillance. The information gathered from in-depth interviews and documentary studies is then discussed in the focus group discussion to identify the necessary data and information in attaining information system integration in school-based and community-based surveillance. Observation sheets and focus group discussion guidelines are used to conduct the documentary studies and focus group discussions. Data collected from in-depth interviews, documentary studies, and focus group discussions are analyzed using content analysis. The collected data is classified by themes or aspects to be presented in the form of narratives, charts, and tables.

Results

Commented [sh2]: explain the stages of system development and system testing !

104 Our findings show that community has participated in supporting health programs in
105 Indonesia that includes health surveillance and disease control and prevention. This is reflected
106 by the involvement of the community in the recording and reporting of health data. It is
107 evidenced by studies in several countries that suggest the importance of the role of health cadres
108 in handling health problems at a household level and had been documented both in developed
109 countries such as the United States and developing countries such as Brazil, Iran, Pakistan, and
110 sub-Saharan Africa (10,11). Teachers, on the other hand, play an important role as school
111 health service stakeholders in preventing and controlling the diseases that are often found in
112 school-aged children (i.e., soil-transmitted helminthiasis, childhood obesity, stunting, and
113 thinness). Teachers' involvement in recording students' attendance is also of great importance
114 as it is one simple plausible indicator of health evidence in school-aged children. Student
115 absence from school can provide an early warning of some outbreaks (12). For example, a
116 study in China reported that varicella, mumps, and influenza-like outbreaks were successfully
117 identified through the report of student absences from school (13).

118 Health cadres, teachers, and caretakers in the communities, schools, and childcare centers
119 are also able to conduct syndromic surveillance that refers to the use of pre-diagnostic health
120 indicators to enable timely detection and investigation of potential infectious disease outbreaks.
121 It can be considered as an additional approach to routine public health surveillance by allowing
122 early identification of clusters of diseases before the official data are available. Data regarding
123 disease symptoms that has been collected by syndromic surveillance is considered to be one of
124 the important preventive efforts (14). Research in Malawi showed that the Malawi community
125 case management system, a policy aimed at a community-level treatment program for malaria,
126 diarrhea, and pneumonia for children, is a promising strategy to increase the coverage of care
127 for sick children. Although there is still much room for improvement, especially in the
128 assessment and treatment given to the children with suspected pneumonia, identification and
129 referral of sick children with danger signs, health surveillance assistants provide initial
130 treatment for sick children at a level of quality that is like the treatments provided in first-rate
131 health facilities in Malawi. Syndromic surveillance performed in China of symptoms like fever
132 (a condition in which the body temperature rises to more than 37.5°C or self-disclosure of
133 fever), diarrhea (\geq three or more defecations per day), jaundice (a yellow tinge to the skin and
134 whites of the eyes, dark urine, and itchiness), a rash (abnormal skin changes, including pruritus
135 and pain), inflammation of the conjunctiva (reddened, swollen, or burning eyes), inflammation
136 of the parotid gland (swelling on the rear side of the earlobe accompanied by fever and local
137 pain when opening the mouth or chewing), and vomiting accompanied by headache and
138 abdominal pain has the potential to enhance the capacities for early detection of disease
139 outbreaks. Other research conducted by Wahyuni & Artanti (2013) also stated that the findings
140 of patients with suspected tuberculosis can be more effective by training the health cadres to
141 perform the syndromic surveillance.

142 The involvement of the community and schools in the surveillance system must be
143 facilitated with a practical, efficient, and interoperable system. Developing an integrated
144 information system could be the key to increasing communication and information sharing
145 across all levels of care from a community level to mainstream healthcare providers (16).
146 Analyzing and designing the system are important stages in the development of an integrated
147 information system.

148 **System Analysis**

149 This research found that fragmented surveillance systems have caused many registers or
150 recording and reporting formats to produce data that are collected repeatedly in different

151 formats or what is commonly called data redundancy. Data redundancy may cause costs to
 152 overrun, an increase in workload due to the repetition of data recording and reporting, and
 153 inconsistencies. Data redundancy occurs in the characteristics of the target population (mother,
 154 infant, and child), risk factors for pregnancy, childbirth, and postpartum, and types of services
 155 including types of immunization for children. Thus, the integration of current information
 156 systems may be advantageous to minimize unintentional data redundancy cases.

157 The implementation of this research model is based on the continuum of care that refers
 158 to the continuity of care of an individual throughout the major stages of their life cycle. Data
 159 collection is carried out during pregnancy, infancy, growth and development, at school-age,
 160 through health risk behaviors, reproductive years, and mortality. It is collected by health cadres
 161 who are in the system input entities that include *Posyandu*, *Posbindu*, and schools. Reports are
 162 submitted to the output entities, namely the public health centers, district health and education
 163 offices.

164 Table 1. System implementation methods based on *continuum of care*

Period	Pregnancy	Infancy	Growth and Development	School age	Health risk behaviors	Reproductive age	Mortality
Data collector	All health cadres	<i>Posyandu</i> cadres	<i>Posyandu</i> cadres	<i>Posbindu</i> cadres, teachers	<i>Posbindu</i> cadres, teachers	<i>Posyandu</i> cadres	All health cadres
Location	Community, <i>Posyandu</i>	<i>Posyandu</i>	<i>Posyandu</i>	<i>Posbindu</i> , schools	<i>Posbindu</i> , schools	<i>Posyandu</i>	Community
Time	Incidental and routine on <i>Posyandu</i>	Routine on <i>Posyandu</i>	Routine on <i>Posyandu</i>	Incidental and routine on <i>Posyandu</i> or school health services activities	Incidental and routine on <i>Posyandu</i> or school health services activities	Routine on <i>Posyandu</i>	Incidental

165

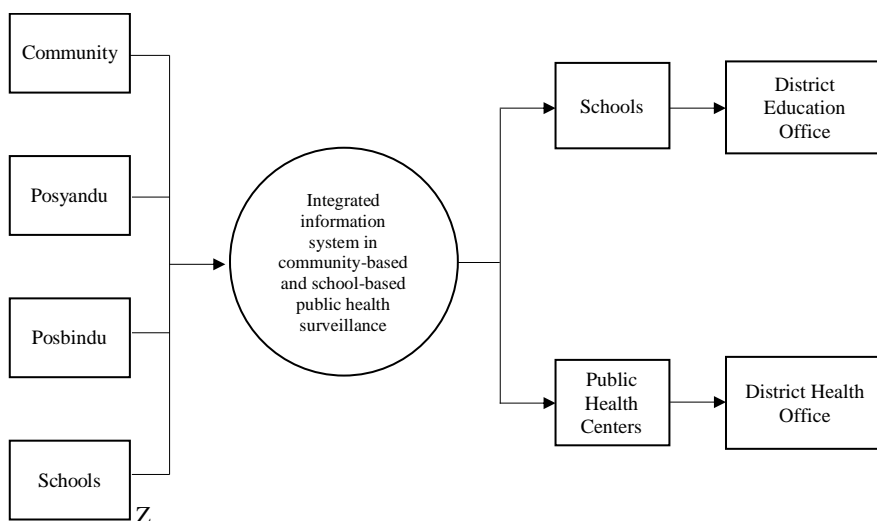
166 Table 1. shows that the efforts to reach a continuity of care are conducted in various
 167 health programs. The community and schools play significant roles in every health program
 168 through *Posyandu*, *Posbindu*, and schools, including in recording and reporting health data
 169 from the stage of pregnancy until mortality. Our finding is consistent with earlier research
 170 conducted by Saepudin et al. (2017) that stated *Posyandu* has become a public health
 171 information center that leads to the understanding of the health needs required to provide the
 172 right care for mothers and children. *Posbindu*, which is defined as the manifestation of the
 173 involvement of the community in early detection and monitoring of main non-communicable
 174 diseases in integrated, routine, and periodic manners (18), also has a great significance in
 175 conducting prevention activities. This may be through health promotion, screening, and
 176 monitoring of the risk factors of non-communicable diseases along with detecting the cases as
 177 early as possible to provide immediate treatment (19).

178

179 **System Design**

180 The results obtained from the system analysis will be the material for the next stage of
181 system development, namely the design of the system. System design is a stage to describe the
182 formation of a system and to configure the components of both system hardware and software.
183 Context diagrams and data flow diagrams (DFD) are used to describe the system models. The
184 context diagram is used to describe the relationships between entities involved in the system.
185 The description of the data and information flow in the system is demonstrated by the data flow
186 diagram. The context diagram can be seen in Figure 2 below.

187



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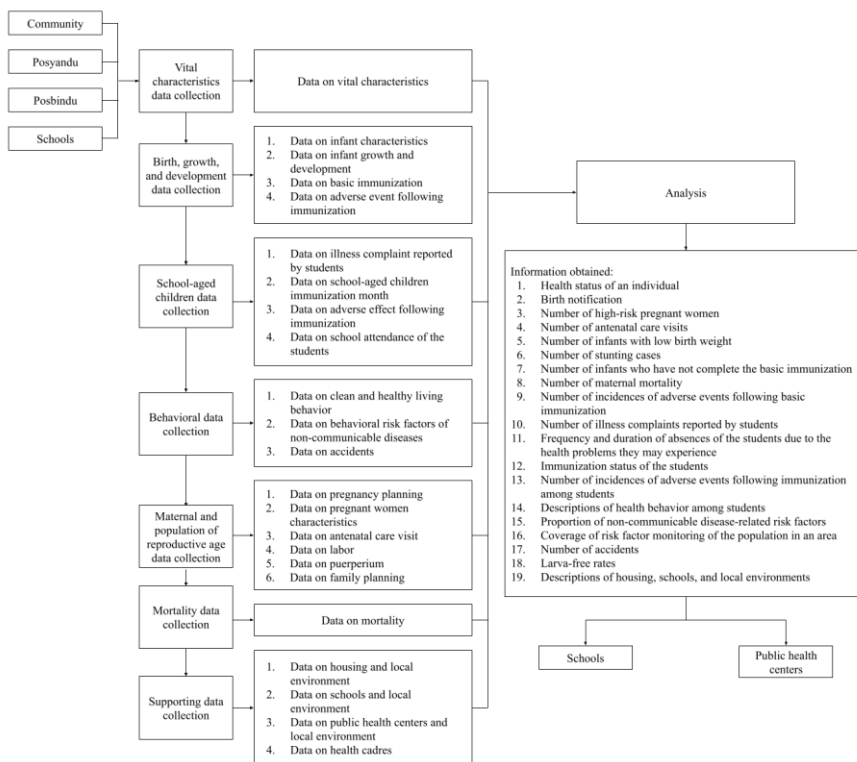
189 **Figure 2.** Context diagram in integrated health information systems in community-based and
190 school-based public health surveillance

191 An integrated health information system may improve the effectiveness and efficiency
192 of health services through better management at all levels of the service (20). Furthermore,
193 allowing different providers, organizations, and sectors to communicate with each other that
194 can be achieved by integrating health information systems, is necessary to identify and provide
195 responses to health and well-being related dimensions throughout an individual's lifespan in
196 all healthcare settings. Faridah et al. (2020) stated that an integrated health information system
197 is required in the planning and implementation of health interventions to promote a better
198 health system by helping the stakeholders to assess the health needs of the population and
199 evaluating the effectiveness and efficiency of health programs.

200 Integrating the efforts of the entities to collect, process, report, and use health information
201 requires the development of integrated health information systems for the community through
202 *Posyandu* and *Posbindu* cadres and schools. The availability of reliable and timely health
203 information from the input entities could allow the district education and health offices as the
204 policymakers to come to decisions that are evidence-based and strategic. The flow of
205 information through the system is described in Figure 3.

Commented [sh3]: Context diagrams do not match the rules: 1. No explanation on arrows 2. No label on entity 3. There should be no direct relationship between entities 4. duplicate entities

Commented [sh4]: explain when the data will be integrated who will be in charge of maintaining the validity of the data from each related sector? Especially data from the Community/Society !



206
207 Figure 3. Data flow diagram in integrated health information systems in community-based
208 and school-based public health surveillance

209 Data generated from input entities include data on vital characteristics, birth, growth and
210 development of the children, data on school-aged children, health behavior, maternal health
211 and the population at reproductive age, mortality, and all supporting data. Data on birth, growth
212 and development of the children include characteristics, growth and development of the infant,
213 completion of basic immunization, and adverse events following immunization (AEFI) on
214 infants. Data on school-aged children include illness complaints reported by the students,
215 completion of basic immunization, AEFI, and school attendance of the students. Data on health
216 behavior include data on clean and healthy living behavior and non-communicable diseases-
217 related risk behaviors. Data on maternal health and the population at reproductive age include
218 family and pregnancy planning, characteristics of pregnant women, completion of antenatal
219 care visits, labor, puerperium, and family planning. Data on mortality record the time, place,
220 and cause of mortality. Data are compiled in a recording and reporting format that is integrated
221 into a school-based and community-based public health surveillance information system
222 model.

223 The data collected will be processed to produce the following information: the health
224 status of the community both for the individual and as a family; the number of high-risk
225 pregnant women; the number of antenatal care visits; the number of babies with low birth
226 weight; the number of infants who have not completed basic immunization; the number of

227 infants and mortality; the number of incidences of adverse effects following basic
228 immunizations; the number of illness complaints reported by students; the frequency and
229 duration of absences of the students due to the health problems they may experience; the
230 immunization status of the students; the number of incidences of adverse effects following
231 immunization among students; descriptions of behavioral health among students; the
232 proportion of non-communicable disease-related risk factors; the coverage of risk factors of
233 the population in an area; the number of accidents; larva-free rates; and descriptions of home
234 and school environments. These epidemiological data can be utilized to improve the prevention
235 of and early detection efforts to reduce the risk of the possibilities of several diseases'
236 occurrence. For example, data on larva-free rates and descriptions of the home and school
237 environments are important to understand the modes of transmission and to support the
238 decision-making of an action plan for handling dengue fever effectively and efficiently (22).

239 Santoso (2005) stated that health promotion and disease prevention efforts can be carried
240 out through continuous and systematic studies of various types of diseases, especially those
241 with the potential for outbreaks by conducting disease surveillance, analyzing the vulnerability
242 of the community (e.g., immunization coverage), the environment, and other data in the
243 epidemiological surveillance network that are developed through the health information
244 system. Schools are one of the strategic places to conduct public health surveillance as they
245 can facilitate the outreach of health programs to school-age children that are considered to be
246 a vulnerable population. (24). Research conducted in Ethiopia showed that food insecurity has
247 been shown to be a determinant of student absence (25). Other research in Indonesia found an
248 outbreak of Hepatitis A in one of the high schools in Lamongan Regency by identifying the
249 risk factors; these included shared utensils with the infected person, poor personal hygiene
250 habits, poor sanitation, lack of hygiene and sanitation facilities, poor food hygiene
251 management, and inadequate sources of clean and hygienic water (26).

252 Some innovative principles of public health surveillance had been introduced, including
253 the use of cloud-based, electronic data collection and management and the use of case-based
254 reports within the consultation. These features are hypothesized to bring several advantages
255 such as the use of clinical decision support for diseases' diagnosis and management, data
256 standardization and coding, provision of timely and reliable analysis and reporting and
257 implementation that is cost-effective (27). This is in accordance with (28) who said that
258 technological developments have contributed significantly to improving the data quality and
259 simplifying health information management activities so that health data management can be
260 carried out more effectively and efficiently.

261 Successful information flow requires ensuring that information be recorded
262 electronically, managed, governed, regulated, linked via a master index, and be made available
263 to users through one or more interconnected software applications (29) as conveyed by (30)
264 that an electronic health information system must be built to facilitate data exchange. With the
265 existence of a health information system that provides access in digital format, it is expected
266 that health workers can easily track patients' data over time, identify patients who are scheduled
267 for preventive visits and screenings, and enhance the overall quality of patient care provided
268 by the practice (31). Health information that is carried out in an integrated manner can help
269 health workers in providing better health services (32). This is supported by the research of
270 Kiberu et al. (2014) that stated that the application of systems and the use of technology is very
271 important to support health information management activities.

272 Technology that continues to develop may increase the potential of an integrated health
273 information system to enhance the early screening and diagnostics of diseases that leads to cost

274 reduction and efficiency for the health services of both non-communicable and communicable
275 diseases (34). The application of a health information system through a website-based
276 application is used to make it easier to provide access to health information (35). The existence
277 of a technology-based health information system also helps to reduce workload, paper usage
278 (becoming paperless), and supports decision-making for health service providers (36).

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1 **Analysis of integrated information systems in**
2 **community-based and school-based public health surveillance**
3

4 **Abstract**

5 The involvement of the community in supporting health programs requires an integrated
6 information system. Public health registers obtained by the community means some data is
7 collected repeatedly in different formats or leads to data redundancy. This research aims to
8 analyze and design an integrated information system model of current community-based and
9 school-based public health surveillance based on a system development life cycle (SDLC)
10 approach. Data analysis is carried out using content analysis. The results show that entities
11 involved in the system include health cadres in *Posyandu* (an integrated health post for
12 maternal and child health), *Posbindu* (an integrated development post of non-communicable
13 disease), and school health services. The necessary data include data on vital characteristics,
14 maternal and child health, the risk factors of both communicable and non-communicable
15 diseases, students' illness complaints, clean and healthy living behavior, mortality, and
16 environmental health. Information obtained includes the health status of an individual,
17 planning on pregnancy and labor, antenatal care visits, stunting data, immunization status,
18 students' illness complaints, the number of accidents, larva-free rate, and mortality rate.
19 Information from the system is reported to public health centers, the district health office, and
20 district education office. The output of the system is useful to complement the recording and
21 reporting of data from health facilities.

22 **Keywords:** integration, health system, community-based, school-based, surveillance

23 Introduction

24 Indonesia is struggling to face the triple burden of disease as a result of the increasing
25 prevalence of non-communicable diseases (e.g., diabetes mellitus, hypertension, and stroke)
26 and incidences of re-emerging and new-emerging diseases (e.g., SARS, avian influenza, and
27 swine influenza) while the infectious diseases (e.g., tuberculosis and HIV/AIDS) are still on
28 the rise (1). For instance, according to the latest national survey in 2018, the prevalence of
29 diabetes mellitus among adults of 15 years and above reached the number of 10.9% (2). Based
30 on Global TB Report, the incidence of Tuberculosis at the same year reached 570,289 cases
31 (3). Indonesia is also considered to be one of six countries for highly pathogenic avian influenza
32 H5N1 (4). To respond to this challenge, the government of Indonesia has initiated the
33 involvement of health information systems. However, these systems remain disease-specific,
34 fragmented, and unconsolidated. For example, the HIV and AIDS information system (SIHA)
35 was implemented to integrate a HIV and AIDS recording and reporting system (5), the
36 integrated tuberculosis information system (SITT) (6), and registers for maternal and child
37 health (7).

38 Health surveillance is defined as a continuous, systematic collection, analysis, and
39 interpretation of health-related data that are essential to the planning, implementation, and
40 evaluation of health practice. Health surveillance plays an important role in providing evidence
41 to facilitate the prevention and control of diseases (8). Health surveillance is one of the
42 subsystems in the national health system of Indonesia that is regulated by the Presidential
43 Regulation of the Republic of Indonesia Number 72 of the year 2012 on the National Health
44 System. As one of the data sources that can be conducted through both active and passive
45 surveillance, the involvement of community members is important to improve data quality.

46 The involvement of the community in health surveillance is reflected by the role of health
47 cadres through *Posyandu* (an integrated health post for maternal and child health), *Posbindu*
48 (an integrated development post of non-communicable disease), and school health services.
49 Health programs carried out by the community are expected to be comprehensive and
50 continuous in accordance with the continuum of care. The continuum of care is a strategic
51 approach in looking at health problems in a comprehensive range from the birth to death of an
52 individual (9). This approach helps healthcare providers meet the needs of an individual
53 through life's transition considering that the individual may be more vulnerable and susceptible
54 to health problems during discontinuities or gaps in care (10). For instance, it is evidenced by
55 (11) that maternal health status can be used as a risk factor predictor for the mother and the
56 baby she conceived and bore. This confirms that the relationships between mothers and babies
57 cannot be separated in terms of the need for health services.

58 One of the efforts that can be made to effectively sustain the health programs is to
59 integrate the program. Integration refers to the act of adoption or assimilation of smaller health
60 interventions into a single health system that functions as one ((12)). (13)) stated that
61 information systems are one of the key principles in the success of integrated health systems.
62 Information system integration can be carried out through developing current information
63 systems in the context of data management and usage. An integrated information system
64 connects users, providers, and various parties related to their health problems. This study aims
65 to develop an integrated information system model of school-based and community-based
66 public health surveillance.

67 Design and Methods

68 The result of this study is part of a multiyear sequencing study that was conducted from
69 February 2018 to November 2020 through the integration of recording and reporting systems
70 in community-based and school-based surveillance. The conceptual framework is based on
71 the continuum of care approach (14) and the system approach (9). Continuum of care refers
72 to the continuity of care from the birth to death of an individual. The research conceptual
73 framework is presented in Figure 1.

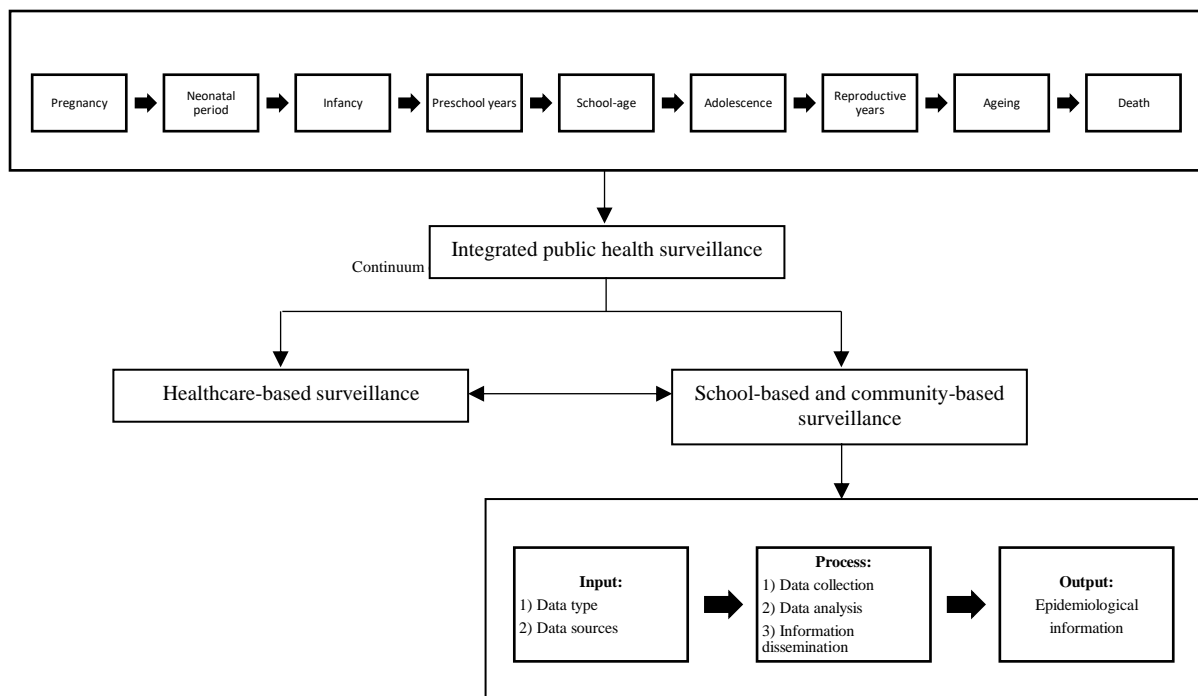


Figure 1. Conceptual framework

This research is operational research in developing current health information systems with variables including data types, data sources, data collection, data analysis, information dissemination, and epidemiological information based on a system development life cycle (SDLC) approach. This approach includes system analysis, system design, system implementation, and system maintenance. The SDLC stages performed in this study were system analysis and system design as part of the system approach. System analysis describes the ongoing surveillance information system based on its components, namely input, process, and output, to identify and evaluate problems, opportunities, obstacles that may occur, and expected needs in order to achieve improvements, especially data and information. These stages were conducted to identify the data and information required by the integrated surveillance information system. System design is further conducted to define functional needs, prepare the implementation design, describe how the system is developed, and configure both the software and hardware of the system, by developing an application prototype through data flow diagrams (DFD). The system that had been designed is further tested and installed at the stage of system implementation and occasionally maintained through security operations and administration, operational assurance, audits, and monitoring (15).

The city of Surabaya was chosen to be the research location due to the high prevalence of health problems that occurred. The research information is obtained from surveillance staff at the Surabaya City Health Office, school healthcare unit providers, and health cadres in *Posyandu* and *Posbindu*. Data collection is carried out by in-depth interviews, documentary studies, and focus group discussions. The documentary studies are conducted on the recording and reporting formats used in the ongoing school-based and community-based surveillance. The information gathered from in-depth interviews and documentary studies is then discussed in the focus group discussion to identify the necessary data and information in attaining information system integration in school-based and community-based surveillance. Observation sheets and focus group discussion guidelines are used to conduct the documentary studies and focus group discussions. Data collected from in-depth interviews, documentary

111 studies, and focus group discussions are analyzed using content analysis. The collected data is
112 classified by themes or aspects to be presented in the form of narratives, charts, and tables.

113 **Results**

114 Our findings show that community has participated in supporting health programs in
115 Indonesia that includes health surveillance and disease control and prevention. This is reflected
116 by the involvement of the community in the recording and reporting of health data. It is
117 evidenced by studies in several countries that suggest the importance of the role of health cadres
118 in handling health problems at a household level and had been documented both in developed
119 countries such as the United States and developing countries such as Brazil, Iran, Pakistan, and
120 sub-Saharan Africa (16,17). Teachers, on the other hand, play an important role as school
121 health service stakeholders in preventing and controlling the diseases that are often found in
122 school-aged children (i.e., soil-transmitted helminthiasis, childhood obesity, stunting, and
123 thinness). Teachers' involvement in recording students' attendance is also of great importance
124 as it is one simple plausible indicator of health evidence in school-aged children. Student
125 absence from school can provide an early warning of some outbreaks (18). For example, a
126 study in China reported that varicella, mumps, and influenza-like outbreaks were successfully
127 identified through the report of student absences from school (19).

128 Health cadres, teachers, and caretakers in the communities, schools, and childcare centers
129 are also able to conduct syndromic surveillance that refers to the use of pre-diagnostic health
130 indicators to enable timely detection and investigation of potential infectious disease outbreaks.
131 It can be considered as an additional approach to routine public health surveillance by allowing
132 early identification of clusters of diseases before the official data are available. Data regarding
133 disease symptoms that has been collected by syndromic surveillance is considered to be one of
134 the important preventive efforts (20). Research in Malawi showed that the Malawi community
135 case management system, a policy aimed at a community-level treatment program for malaria,
136 diarrhea, and pneumonia for children, is a promising strategy to increase the coverage of care
137 for sick children. Although there is still much room for improvement, especially in the
138 assessment and treatment given to the children with suspected pneumonia, identification and
139 referral of sick children with danger signs, health surveillance assistants provide initial
140 treatment for sick children at a level of quality that is like the treatments provided in first-rate
141 health facilities in Malawi. Syndromic surveillance performed in China of symptoms like fever
142 (a condition in which the body temperature rises to more than 37.5°C or self-disclosure of
143 fever), diarrhea (\geq three or more defecations per day), jaundice (a yellow tinge to the skin and
144 whites of the eyes, dark urine, and itchiness), a rash (abnormal skin changes, including pruritus
145 and pain), inflammation of the conjunctiva (reddened, swollen, or burning eyes), inflammation
146 of the parotid gland (swelling on the rear side of the earlobe accompanied by fever and local
147 pain when opening the mouth or chewing), and vomiting accompanied by headache and
148 abdominal pain has the potential to enhance the capacities for early detection of disease
149 outbreaks. Other research conducted by Wahyuni & Artanti (2013) also stated that the findings
150 of patients with suspected tuberculosis can be more effective by training the health cadres to
151 perform the syndromic surveillance.

152 The involvement of the community and schools in the surveillance system must be
153 facilitated with a practical, efficient, and interoperable system. Developing an integrated
154 information system could be the key to increasing communication and information sharing
155 across all levels of care from a community level to mainstream healthcare providers (22).
156 Analyzing and designing the system are important stages in the development of an integrated
157 information system.

158 **System Analysis**

159 This research found that fragmented surveillance systems have caused many registers or
 160 recording and reporting formats to produce data that are collected repeatedly in different
 161 formats or what is commonly called data redundancy. Data redundancy may cause costs to
 162 overrun, an increase in workload due to the repetition of data recording and reporting, and
 163 inconsistencies. Data redundancy occurs in the characteristics of the target population (mother,
 164 infant, and child), risk factors for pregnancy, childbirth, and postpartum, and types of services
 165 including types of immunization for children. Thus, the integration of current information
 166 systems may be advantageous to minimize unintentional data redundancy cases.

167 The implementation of this research model is based on the continuum of care that refers
 168 to the continuity of care of an individual throughout the major stages of their life cycle. Data
 169 collection is carried out during pregnancy, infancy, growth and development, at school-age,
 170 through health risk behaviors, reproductive years, and mortality. It is collected by health cadres
 171 who are in the system input entities that include *Posyandu*, *Posbindu*, and schools. Reports are
 172 submitted to the output entities, namely the public health centers, district health and education
 173 offices.

174 Table 1. System implementation methods based on *continuum of care*

Period	Pregnan cy	Infancy	Growth and Develop ment	School age	Health risk behavior s	Reprodu ctive age	Mortalit y
Data collector	All health cadres	<i>Posyandu</i> cadres	<i>Posyandu</i> cadres	<i>Posbindu</i> cadres, teachers	<i>Posbindu</i> cadres, teachers	<i>Posyandu</i> cadres	All health cadres
Location	Community, <i>Posyandu</i>	<i>Posyandu</i>	<i>Posyandu</i>	<i>Posbindu</i> , schools	<i>Posbindu</i> , schools	<i>Posyandu</i>	Community
Time	Incidental and routine <i>Posyandu</i>	Routine <i>Posyandu</i>	Routine <i>Posyandu</i>	Incidental and routine <i>Posyandu</i> or school health services activities	Incidental and routine <i>Posyandu</i> or school health services activities	Routine <i>Posyandu</i>	Incidental

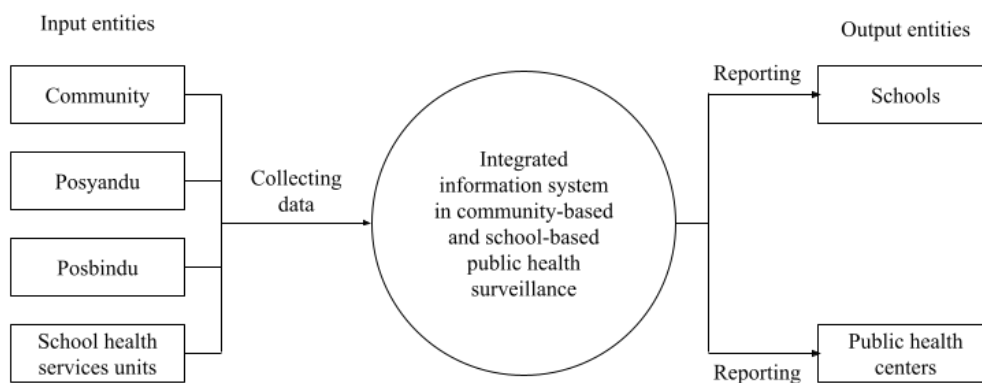
175
 176 Table 1. shows that the efforts to reach a continuity of care are conducted in various
 177 health programs. The community and schools play significant roles in every health program
 178 through *Posyandu*, *Posbindu*, and schools, including in recording and reporting health data
 179 from the stage of pregnancy until mortality. Our finding is consistent with earlier research
 180 conducted by Saepudin et al. (2017) that stated *Posyandu* has become a public health

181 information center that leads to the understanding of the health needs required to provide the
182 right care for mothers and children. *Posbindu*, which is defined as the manifestation of the
183 involvement of the community in early detection and monitoring of main non-communicable
184 diseases in integrated, routine, and periodic manners (24), also has a great significance in
185 conducting prevention activities. This may be through health promotion, screening, and
186 monitoring of the risk factors of non-communicable diseases along with detecting the cases as
187 early as possible to provide immediate treatment (25).

188

189 **System Design**

190 The results obtained from the system analysis will be the material for the next stage of
191 system development, namely the design of the system. System design is a stage to describe the
192 formation of a system and to configure the components of both system hardware and software.
193 Context diagrams and data flow diagrams (DFD) are used to describe the system models. The
194 context diagram is used to describe the relationships between entities involved in the system.
195 The description of the data and information flow in the system is demonstrated by the data flow
196 diagram. The context diagram can be seen in Figure 2 below.

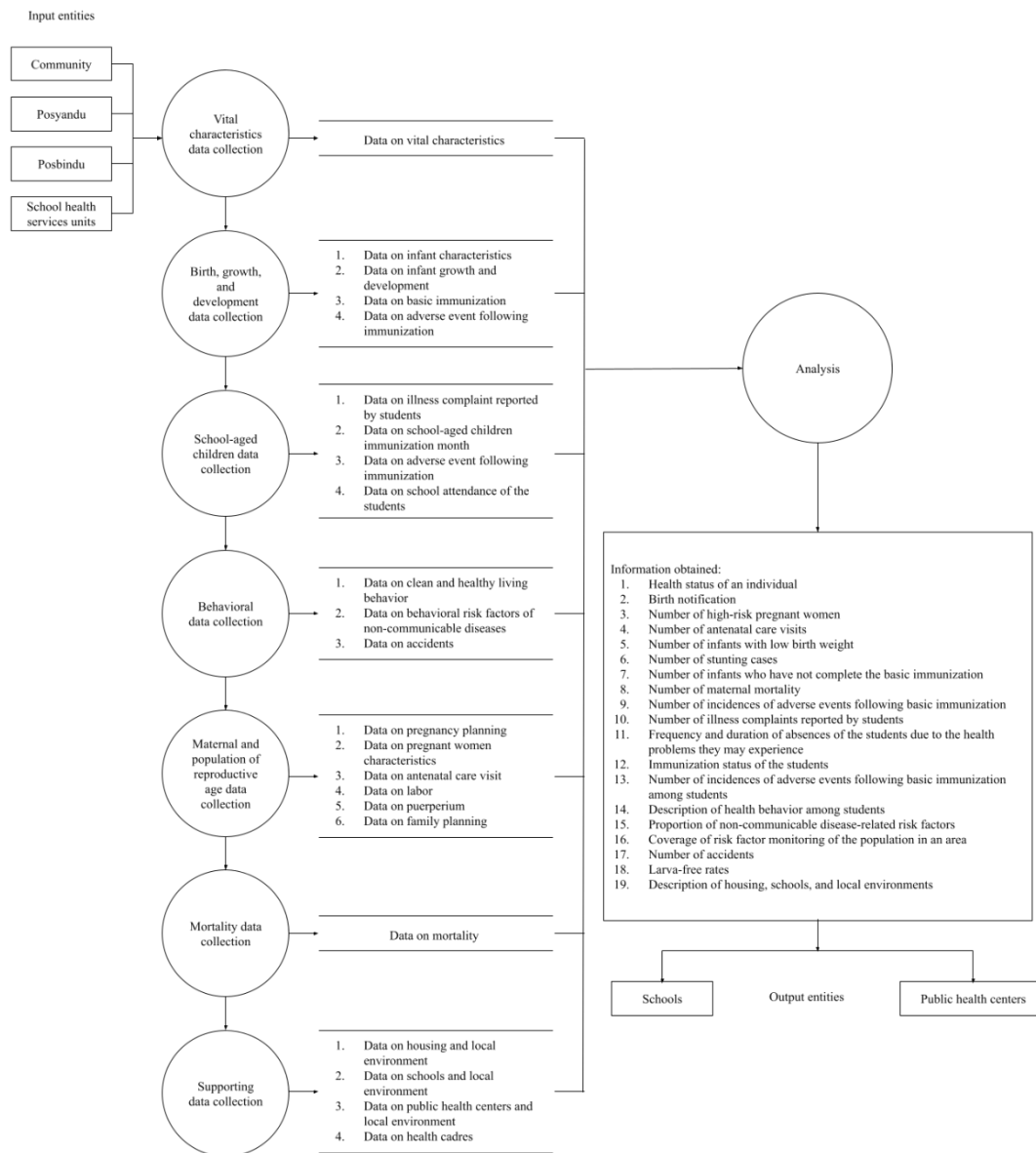


197

198 Figure 2. Context diagram in integrated health information systems in community-based and
199 school-based public health surveillance

200 An integrated health information system may improve the effectiveness and efficiency
201 of health services through better management at all levels of the service (26). Furthermore,
202 allowing different providers, organizations, and sectors to communicate with each other that
203 can be achieved by integrating health information systems, is necessary to identify and provide
204 responses to health and well-being related dimensions throughout an individual's lifespan in
205 all healthcare settings. Faridah et al. (2020) stated that an integrated health information system
206 is required in the planning and implementation of health interventions to promote a better
207 health system by helping the stakeholders to assess the health needs of the population and
208 evaluating the effectiveness and efficiency of health programs.

209 Integrating the efforts of the entities to collect, process, report, and use health information
210 requires the development of integrated health information systems for the community through
211 *Posyandu* and *Posbindu* cadres and school health services units. Data that had been collected
212 will be validated by schools and public health centers to be reported to District Education
213 Office and District Health Office. The availability of reliable and timely health information
214 from the input entities could allow the district education and health offices as the policymakers
215 to come to decisions that are evidence-based and strategic. The flow of information through
216 the system is described in Figure 3.



217

218 Figure 3. Data flow diagram in integrated health information systems in community-based
219 and school-based public health surveillance

220 Data generated from input entities include data on vital characteristics, birth, growth and
221 development of the children, data on school-aged children, health behavior, maternal health
222 and the population at reproductive age, mortality, and all supporting data. Data on birth, growth
223 and development of the children include characteristics, growth and development of the infant,
224 completion of basic immunization, and adverse events following immunization (AEFI) on
225 infants. Data on school-aged children include illness complaints reported by the students,
226 completion of basic immunization, AEFI, and school attendance of the students. Data on health
227 behavior include data on clean and healthy living behavior and non-communicable diseases-
228 related risk behaviors. Data on maternal health and the population at reproductive age include
229 family and pregnancy planning, characteristics of pregnant women, completion of antenatal
230 care visits, labor, puerperium, and family planning. Data on mortality record the time, place,
231 and cause of mortality. Data are compiled in a recording and reporting format that is integrated

232 into a school-based and community-based public health surveillance information system
233 model.

234 The data collected will be processed to produce the following information: the health
235 status of the community both for the individual and as a family; the number of high-risk
236 pregnant women; the number of antenatal care visits; the number of babies with low birth
237 weight; the number of infants who have not completed basic immunization; the number of
238 infants and mortality; the number of incidences of adverse effects following basic
239 immunizations; the number of illness complaints reported by students; the frequency and
240 duration of absences of the students due to the health problems they may experience; the
241 immunization status of the students; the number of incidences of adverse effects following
242 immunization among students; descriptions of behavioral health among students; the
243 proportion of non-communicable disease-related risk factors; the coverage of risk factors of
244 the population in an area; the number of accidents; larva-free rates; and descriptions of home
245 and school environments. These epidemiological data can be utilized to improve the prevention
246 of and early detection efforts to reduce the risk of the possibilities of several diseases'
247 occurrence. For example, data on larva-free rates and descriptions of the home and school
248 environments are important to understand the modes of transmission and to support the
249 decision-making of an action plan for handling dengue fever effectively and efficiently (28).

250 Santoso et al. stated that health promotion and disease prevention efforts can be carried
251 out through continuous and systematic studies of various types of diseases, especially those
252 with the potential for outbreaks by conducting disease surveillance, analyzing the vulnerability
253 of the community (e.g., immunization coverage), the environment, and other data in the
254 epidemiological surveillance network that are developed through the health information system
255 (29) stated that health promotion and disease prevention efforts can be carried out through
256 continuous and systematic studies of various types of diseases, especially those with the
257 potential for outbreaks by conducting disease surveillance, analyzing the vulnerability of the
258 community (e.g., immunization coverage), the environment, and other data in the
259 epidemiological surveillance network that are developed through the health information
260 system. Schools are one of the strategic places to conduct public health surveillance as they
261 can facilitate the outreach of health programs to school-age children that are considered to be
262 a vulnerable population. (30). Research conducted in Ethiopia showed that food insecurity has
263 been shown to be a determinant of student absence (31). Other research in Indonesia found an
264 outbreak of Hepatitis A in one of the high schools in Lamongan Regency by identifying the
265 risk factors; these included shared utensils with the infected person, poor personal hygiene
266 habits, poor sanitation, lack of hygiene and sanitation facilities, poor food hygiene
267 management, and inadequate sources of clean and hygienic water (32).

268 Some innovative principles of public health surveillance had been introduced, including
269 the use of cloud-based, electronic data collection and management and the use of case-based
270 reports within the consultation. These features are hypothesized to bring several advantages
271 such as the use of clinical decision support for diseases' diagnosis and management, data
272 standardization and coding, provision of timely and reliable analysis and reporting and
273 implementation that is cost-effective (33). This is in accordance with (34) who said that
274 technological developments have contributed significantly to improving the data quality and
275 simplifying health information management activities so that health data management can be
276 carried out more effectively and efficiently.

277 Successful information flow requires ensuring that information be recorded
278 electronically, managed, governed, regulated, linked via a master index, and be made available

279 to users through one or more interconnected software applications (35) as conveyed by (36)
280 that an electronic health information system must be built to facilitate data exchange. With the
281 existence of a health information system that provides access in digital format, it is expected
282 that health workers can easily track patients' data over time, identify patients who are scheduled
283 for preventive visits and screenings, and enhance the overall quality of patient care provided
284 by the practice (37). Health information that is carried out in an integrated manner can help
285 health workers in providing better health services (38). This is supported by the research of
286 (39) that stated that the application of systems and the use of technology is very important to
287 support health information management activities.

288 Technology that continues to develop may increase the potential of an integrated health
289 information system to enhance the early screening and diagnostics of diseases that leads to cost
290 reduction and efficiency for the health services of both non-communicable and communicable
291 diseases (40). The application of a health information system through a website-based
292 application is used to make it easier to provide access to health information (41). The existence
293 of a technology-based health information system also helps to reduce workload, paper usage
294 (becoming paperless), and supports decision-making for health service providers (42).

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[OAMJMS] Editor Decision

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Arief Hargono, Kurnia Dwi Artanti, Fariani Syahrul, Evi Lioni (Author):

We have reached a decision regarding your submission to Open Access Macedonian Journal of Medical Sciences, "Analysis of integrated information systems in community-based and school-based public health surveillance", Manuscript ID = OJS9346.

Our decision is to:Accept your revised manuscript for publication in OAMJMS.



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