



## **Literature Review: Use of Smartphone Applications for Drug Taking Supervisors (DTS) in TB Treatment**

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### **ABSTRACT**

*Background: Tuberculosis is one of the leading causes of death in the world, with an estimated 8 million new cases and 3 million deaths due to tuberculosis each year. The family is the biggest motivator, educator, facilitator, initiator and mediator in providing care for family members who are suffering. Family support plays a very important role in improving medication adherence and ensuring regularity in taking medication and undergoing treatment requires a DTS. Cellular phone technology helps health services to provide health interventions to people who may*

*be difficult to reach. Smartphones have several applications that have been used to support health services, including promoting TB treatment adherence. The purpose of this study was to determine the effectiveness of using a smartphone application for DTS in the treatment of tuberculosis. The method used in this research is Literature Review. The result of this research is that smartphone media is effective in helping the role of DTS in assisting TB. In handling TB, apart from being a reminder to take medication, smartphone applications are also able to improve communication between clients and health workers and minimize barriers to access to health care facilities. The conclusion of this study is that the Drug Administration Supervisor (DTS) has a significant role in the successful treatment of TB patients. In fact, the cure rate of TB patients who were accompanied by DTS was greater than that of patients who were not accompanied by DTS. Smartphone media is effective in increasing treatment adherence of TB patients compared to direct observation.*

**Keywords:** Tuberculosis, smartphone, Drug Taking Supervisors (DTS)

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## Introduction

Tuberculosis or commonly called TB is an infectious disease caused by *Mycobacterium tuberculosis*, usually spread through patient droplets. Tuberculosis is usually characterized by symptoms of cough and phlegm for 2 weeks or more, then sputum may be mixed with blood, weight loss, night sweats without activity, and fever for more than a month (R Wulandari, Kusumawati, and Prabamurti 2021).

In the world, TB is one of the ten leading causes of death. In 2017, an estimated 1.3 million TB deaths occurred in HIV-negative people and an additional 300,000 in HIV-positive people. It is estimated that ten million people in the world were affected by TB in 2017 with details of 5.8 million suffered by men, 3.2 million women and 1 million children. That's why TB is still a top priority in the world and is one of the goals in the Sustainability Development Goals (SDGs) (Kementerian Kesehatan RI 2019).

According to the 2015 WHO report, the number of TB cases in Indonesia is estimated to be 1 million new TB cases per year (399 per 100,000 population) with 100,000 deaths per year (41 per 100,000 population). An estimated 63,000 TB cases are HIV positive (25 per 100,000 population). The Case Notification Rate (CNR) of all cases was reported as 129 per 100,000 population. The total number of cases is 324,539 cases, of which 314,965 are new cases. Nationally, the estimated prevalence of HIV among TB patients is estimated at 6.2%. The number of TB-RO cases is estimated to be 6700 cases originating from 1.9% of TBRO cases from new TB cases and 12% of RO-TB cases from TB with re-treatment (Kementerian Kesehatan 2016).

The global commitment to ending Tuberculosis is stated in the End TB Strategy which targets a reduction in deaths from tuberculosis by 90% by 2030 compared to 2015, a reduction in the incidence of Tuberculosis by 80% in 2035 compared to 2015, and no household will experience catastrophic costs due to TB. TB by 2030. In the End TB strategy, it is emphasized that the target is expected to be achieved through innovations, such as the development of vaccines and TB drugs with short-term regimens (Kementerian Kesehatan 2020).

The family is the biggest motivator, educator, facilitator, initiator and mediator in providing care for family members who are suffering. Family support plays a very important role in improving medication adherence. The role of the family is very important in every aspect of health care for family members. For this reason, the family plays a role in determining the way of care needed by the family (Kalengkongan, Wuaten, and Lalombo 2020).

The success of taking medicine is the most important thing in an effort to cure disease. Factors such as knowledge, family support, motivation to take medication and low IEC have an influence on the treatment of pulmonary TB. The large number of non-adherence to treatment will



result in a high rate of treatment failure for pulmonary TB patients, drop out events and cause more and more pulmonary TB patients with resistant AFB to be found or also known as MDR-TB (Multi Drugs Resistant) (Napitupulu and Harahap 2020).

In the TB treatment process, to ensure regularity in taking medication and undergoing treatment, a DTS is needed (Maulidya, Redjeki, and Fanani 2017). Drug taking supervisor (DTS) is someone who lives near the patient's house or who lives in the same house with the patient so that he can supervise the patient until he actually swallows the drug every day so that there is no drop out of medication and this is done voluntarily. A DTS should be a member of his own family, namely his child or partner, for reasons that are more trustworthy. In addition, the close emotional relationship greatly affects the DTS in addition to being a drug taking supervisor as well as providing emotional support to TB sufferers (Napitupulu and Harahap 2020).

The number of cellular phone users is increasing from year to year. The number of cellular phone users in the world reaches 5.15 billion people (66.60%), while the number of smart phone users reaches 3.3 billion people (42.63) in the world. Cellular phone technology helps health services to provide health interventions to people who may be difficult to reach. Smartphones have several applications that have been used to support health services, including promoting TB treatment adherence. The use of smartphones as a reminder to take TB medicine has been carried out in India. This study reported that as many as 74.1% of clients said they chose to use voice calls for health consultations, 66.5% of clients requested that medication reminders be sent at certain times such as during the day, 11.9% of clients suggested synchronization between reminders and treatment schedules, and 21.6% of clients have no time preference. A total of 76.8% chose video as a monitoring medium for TB treatment compared to direct observation of treatment (Jauhar et al. 2021).

To address this issue, there is an opportunity in using health intervention media to address the challenges of medication adherence, provide patient-centred care, and support health care systems. Mobile technologies, such as smartphone applications, have shown promising potential in dealing with health problems (Lin et al. 2019). From the background above, the formulation of the problem is how is the effect of using a smartphone application for DTS in the treatment of TB patients?

## **Methods**

This research is a literature review research with a simple systematic approach (simplified approach systematic review). The databases used are Google Scholar and PubMed. The keywords used are “TBC”, “SMARTPHONE”, “DTS”, “DTS ROLE”, “Tuberculosis”. The article search process was carried out in February – April 2022. The inclusion criteria used were (1) Indonesian



and English research articles, (2) open access, (3) full text, (4) Publications within the last 7 years (2016 – 2016). 2022), (5) This literature review also uses literature in books or proceedings related to Media Effectiveness in DTS. The exclusion criteria set were articles originating outside the database that were not mentioned and the article was a review article.

## Results and Discussion

Based on the results of the search for research articles, there are several studies that explain smartphone media in handling health problems and the role of Drug Drinking Supervisors (DTS) in TB assistance as shown in the table below.

**Table 1.**

| No | Title                                                                                                                                                           | Author/Year                         | Methodology                                                                                                                                                     | Result                                                                                                                                                   |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Converting and expanding mobile support tools for tuberculosis treatment support: Design recommendations from domain and design experts (Iribaren et al. 2020). | Sarah J. Iribarren dkk / 2020       | The method used is a prototype test that is carried out repeatedly and evaluates previous research by experts.                                                  | Overall experts agree that these applications are easy to learn and use. Some improvements are needed to simplify reporting, simplify features for users |
| 2. | Design, development and randomised controlled trial of a smartphone application, 'QinTB', for smoking cessation in tuberculosis patients: study protocol        | Haoxiang Lin dkk / 2019             | The method used is an experiment by developing a smartphone application based on an interactive transtheoretical model and the theory of protection motivation. | The "QinTB" application is able to help TB patients quit smoking                                                                                         |
| 3. | Dukungan Keluarga Pada Pengobatan Penderita Tb Paru Multi Drug Resistance Yang Tinggal Di Wilayah Kerja Dinas Kesehatan                                         | Detty Jeane Kalengkongan dkk / 2020 | Qualitative with a phenomenological approach                                                                                                                    | Families, health workers and program holders can foster the spirit of patients to remain optimistic about undergoing                                     |



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|----|-------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------|--|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | Kabupaten Kepulauan Sangihe(Kalengkongan, Wuaten, and Lalombo 2020)                                               |                               |                         |  | MDR TB treatment until they achieve recovery                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 4. | Dukungan Sosial Keluarga pada Pasien TB MDR di Kota Semarang(Rizkiana Wulandari, Kusumawati, and Prabamurti 2021) | Rizkiana Wulandari dkk / 2020 | Qualitative descriptive |  | The results showed that the subject had performed the behavior of providing family support to MDR TB patients well. The forms of support provided by the subject are encouraging, giving attention, reminding to take medication, motivating patients, praying, preparing food, taking them to the puskesmas, and fulfilling nutritional needs. Support is given by families who have the closest ties, namely mother, husband, wife, and children. However, it must also be given by family members who do not live in the same house. Several factors behind the provision of support are perceived vulnerability, perceived seriousness, perceived benefits, perceived barriers, self-efficacy, and cues to act. |



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| 5. | Faktor yang mempengaruhi keberhasilan pengobatan tuberkulosis (TB) paru pada pasien pasca pengobatan di Puskesmas Dinoyo Kota Malang (Maulidya, Redjeki, and Fanani 2017)                     | Yulinda Nur Maulidya dkk / 2016 | Case control study with 20 people in the case group and 10 people in the control group               | The patient's attitude and the presence or absence of DTS have a significant relationship with the success of pulmonary TB treatment. Patients who have DTS also tend to have a 13.5 times greater chance of recovery than patients who do not have DTS |
| 6. | Evaluation of the Use of Smartphone Applications in Monitoring Treatment Adherence among Pulmonary Tuberculosis Clients: Systematic Literature Review (Jauhar et al. 2021)                    | M. Jauhar dkk / 2021            | Metode yang digunakan adalah Literatur Review                                                        | The results of this study are smartphone applications have the potential to help the success of pulmonary TB treatment, especially in monitoring treatment                                                                                              |
| 7. | Hubungan peran pengawas menelan obat (DTS) dengan keberhasilan minum obat pasien tuberkulosis paru di wilayah kerja puskesmas ulak tano kab. padang lawas utara (Napitupulu and Harahap 2020) | Mastiur Napitupulu dkk / 2020   | Correlational research                                                                               | There is a significant relationship between the role of DTS on the success of TB treatment at the Ulak Tano Health Center and the community can understand the role of DTS for patients with pulmonary TB                                               |
| 8. | Systematic review pelaksanaan programmatic management of drugresistant tuberculosis pada pasien tuberkulosis                                                                                  | Fitri Aviana / 2021             | This research is a literature review research with a simple systematic approach (simplified approach | - PMDT procedures include patient discovery; diagnosis; treatment; management of                                                                                                                                                                        |



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| resistan obat(Aviana et al. 2021) | systematic review). | <p>patients who drop out of treatment and fail; and treatment in patients with MDR TB co-infection and HIV</p> <ul style="list-style-type: none"> <li>- The results of TB RO treatment with the PMDT strategy showed different results: in Indonesia the success of treatment only reached 47.8%, in India the average success of treatment was 55%, and in Taiwan the success of treatment reached 82.9%</li> <li>- Factors that influence the implementation of TB RO treatment, namely gender, age, patient education level, length of treatment time, financing, and</li> </ul> |
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|     |                                                                                                                                                                                     |                              |                                                              |  | side effects of<br>drugs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|--------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9.  | Peran Pengawas<br>Menelan Obat (DTS)<br>terhadap Hasil<br>Pengobatan Penderita<br>Tuberculosis Paru Di<br>Wilayah Puskesmas<br>Gombong II(Yuda and<br>Utoyo 2018)                   | Hendri Tamara<br>Yuda / 2018 | Cross sectional                                              |  | Based on the research<br>conducted, it was<br>found that 93.75% of<br>DTS supports the<br>treatment process,<br>93.5% of TB treatment<br>results are cured. There<br>is a relationship<br>between the role of the<br>Drug Swallowing<br>Supervisor and the<br>results of TB treatment<br>in the Gombong Health<br>Center area                                                                                                                                                                                                                                                                 |
| 10. | Peran Keluarga Sebagai<br>Pengawas Minum Obat<br>(DTS) Dengan Tingkat<br>Keberhasilan<br>Pengobatan Penderita<br>Tuberkulosis<br>Paru(Jufrizal,<br>Hermansyah, and<br>Mulyadi 2016) | Jufrizal dkk /<br>2016       | Deskriptif<br>korelatif dengan<br>pendekatan<br>retrospektif |  | The results showed<br>that the role of the<br>family as DTS was in<br>both categories<br>(79.4%) and the<br>treatment success rate<br>(73%). There is a<br>relationship between<br>the role of the family as<br>DTS with the success<br>rate of treatment. The<br>role of the family as<br>DTS is related to BTA<br>examination, weight<br>gain, completeness of<br>taking medication. The<br>role of the family as<br>DTS is very decisive in<br>the success of TB<br>treatment. It is hoped<br>that families will care<br>more about TB patients<br>through family control<br>cards so that |



supervision is more  
controlled.

From the table above, it can be explained that in handling TB other than as a reminder to take medication, smartphone applications are also able to improve communication between clients and health workers and minimize barriers to access to health care facilities. It can also be explained that there is a significant relationship between the role of the family as DTS and the success rate of treatment in patients with pulmonary TB (Chen et al. 2021). Families that fulfill a good role as DTS have a 20 times chance of obtaining a successful rate of treatment for patients with pulmonary TB.

The role of the family in the form of participation in the treatment process for patients with pulmonary TB is referring patients to the puskesmas, bringing patients to health workers, helping patients with laboratory examinations, meeting patient needs, reminding patients to take medicine and giving medicine to be taken every night and taking medicine. for supplies, as well as taking patients to carry out control at the puskesmas when they have finished taking the intensive phase (2 months) of medication is very necessary (Yu et al. 2022).

The form of DTS's role shown, among others, is that DTS always monitors patient compliance in taking medication, reminds patients if the drug will run out, and is willing to take patients to take pulmonary TB drugs to the Puskesmas. The role of a good DTS will help in the process of treating TB patients (Jiang et al. 2022).

Cell phones and smart phones have been widely used to support the success of pulmonary TB treatment in the world. In this study, we want to show that smartphone applications have the potential to help the success of pulmonary TB treatment, especially in monitoring treatment. Several smartphone applications that have been used to support successful TB treatment include SMS reminders, Video-Observed Therapy (VOT), WeChat Applications, Mobile Interactive Supervised Therapy (MIST) and Digital Adherence Technologies (DAT) (Zhang, Cui, and Li 2022). These applications are used to complement the standard interventions provided and the results are compared with clients who only receive standard interventions, namely the DOTS program. In research (Haoxiang Lin, 2019), smartphone media while adjusted to the user or target will greatly help the program for handling health problems. In the study, it is necessary to innovate the media used in handling health problems (Tantawi and Hua 2021).

A smartphone application developed to improve medication adherence in pulmonary tuberculosis clients is Mobile Interactive Supervised Therapy (MIST). A total of 82.7% of students assessed the use of the Mobile Interactive Supervised Therapy (MIST) application in monitoring medication adherence (Iribarren et al. 2022). Around 17.3% of students faced technical problems and did not comply with treatment. The use of smartphones demonstrates the feasibility,



acceptability, and accuracy of a medication monitoring and adherence support system. This system has the potential to support the DOTS program and improve treatment adherence for other conditions such as HIV and hepatitis C. Based on previous research, the treatment monitoring program for pulmonary TB also utilizes the WeChat application which is currently widely used by the community, including patients (Xu et al. 2021). The use of this application has been piloted in Mongolia and Xinjiang which are geographically challenging. The results of these trials show good benefits. The strategy used is using the WeChat application which is currently widely used by the community, involving families, and integrating routine TB care in the application (Tortajada-Genaro, Lucío, and Maquieira 2022).

Various kinds of smartphone applications have been developed and run in several countries as an effort to reduce the rate of dropped out treatment in TB patients. The development of smartphone applications is tailored to the characteristics and needs of the community so that these applications can be used as an effective and efficient supporting media (Na and Sheu 2022). Various considerations such as convenience, low cost, prioritizing privacy are important things that need to be considered by health service providers so that they are able to provide benefits to the community, especially patients. The Drug Drinking Supervisor (DTS) in this case acts as a reminder, education provider, encouragement needs to be assisted through an application that is integrated with the TB patient treatment monitoring feature. This will make it easier for DTSs to report on the progress of patient treatment to health workers and make it easier to monitor taking medication for TB patients. The limitation of this research is the limited number of reference sources related to the topic from a database of free and open international journals (Shen et al. 2022).

## **Conclusions**

Several studies have stated that the Drug Taking Supervisor (DTS) has a significant role in the successful treatment of TB patients. In fact, the cure rate of TB patients who were accompanied by DTS was greater than that of patients who were not accompanied by DTS.

Several studies mention the effectiveness of using smartphone applications in improving treatment adherence of TB patients compared to direct observation. Some views say that SMS is considered less effective in monitoring TB treatment. The smartphone application facilitates DTSs in assisting and supervising the treatment of TB patients. However, there are several things that need to be considered in using smartphone applications as reminders to take medication, namely the synchronization between the reminder time and the treatment schedule, carried out at a certain time, and the need to anticipate technical problems that occur. This program needs support from policy makers and TB program implementers from national to local. The increasing number of



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smartphone users is an opportunity in the development of digital technology-based TB treatment monitoring media. This media can be integrated into the TB program that has been implemented in health care facilities.



## References

- Aviana, Fitri et al. 2021. "SYSTEMATIC REVIEW PELAKSANAAN PROGRAMMATIC MANAGEMENT OF DRUG- RESISTANT TUBERCULOSIS PADA PASIEN TUBERKULOSIS RESISTAN OBAT." *Jurnal Kesehatan Masyarakat* 9: 215–22.
- Chen, Chung An et al. 2021. "Smartphone-Assisted Fluorescent Analysis of PolyT-Cu-Nanoprobes Using Nucleic Acid Amplification Test for the Diagnosis of Tuberculosis." *Analytical Biochemistry* 630: 114340. <https://doi.org/10.1016/j.ab.2021.114340>.
- Iribarren, Sarah J et al. 2022. "Articles Patient-Centered Mobile Tuberculosis Treatment Support Tools ( TB-TSTs ) to Improve Treatment Adherence : A Pilot Randomized Controlled Trial Exploring Feasibility , Acceptability and Re Fi Nement Needs." *The Lancet Regional Health - Americas* 13: 100291. <https://doi.org/10.1016/j.lana.2022.100291>.
- Iribarren, SJ, J Wallingford, R Schnall, and G Demiris. 2020. "Converting and Expanding Mobile Support Tools for Tuberculosis Treatment Support: Design Recommendations from Domain and Design Experts." *Journal Biomed Informatics* 5. <https://doi.org/10.1016/j.yjbix.2019.100066>.
- Jauhar, Muhamad et al. 2021. "Evaluation of the Use of Smartphone Applications in Monitoring Treatment Adherence among Pulmonary Tuberculosis Clients: Systematic Literature Review." *Repository.Urecol.Org*: 130.
- Jiang, Ruoxuan et al. 2022. "Multiplex Chroma-Response Based Fluorescent Smartphone Sensing Platform for Rapid and Visual Quantitative Determination of Antibiotic Residues." *Sensors and Actuators B: Chemical* 350(October 2021): 130902. <https://doi.org/10.1016/j.snb.2021.130902>.
- Jufrizal, Hermansyah, and Mulyadi. 2016. "Peran Keluarga Sebagai Pengawas Minum Obat (DTS) Dengan Tingkat Keberhasilan Pengobatan Penderita Tuberkulosis Paru The Family Role As Tuberculosis Treatment Observer with Tuberculosis Treatment Success Level of Pulmonary Tuberculosis Patients Global." *Jurnal Ilmu Keperawatan* 1(4): 25–36.
- Kalengkongan, Detty J., Grace Angel Wuaten, and Agneta Sartika Lalombo. 2020. "Dukungan Keluarga Pada Pengobatan Penderita Tb Paru Multi Drug Resistance Yang Tinggal Di Wilayah Kerja Dinas Kesehatan Kabupaten Kepulauan Sangihe." *Jurnal Ilmiah Sesebanua* 4(2): 57–63.
- Kementerian Kesehatan. 2016. *Profil Dinas Kesehatan Kota Surabaya. Peraturan Menteri Kesehatan Republik Indonesia Nomor 67 Tahun 2016 Tentang Penanggulangan Tuberkulosis*. Jakarta.



- . 2020. *Strategi Nasional Penanggulangan Tuberkulosis Di Indonesia 2020-2024*. In: Strate. Jakarta.
- Kementerian Kesehatan RI. 2019. *Petunjuk Teknis Investigasi Kontak Pasien TBC Bagi Petugas Kesehatan Dan Kader*. Pencegahan. ed. Direktorat Jenderal. Jakarta.
- Lin, H, Y Lin, Y Zheng, and C Chang. 2019. “Design, Development and Randomised Controlled Trial of a Smartphone Application, ‘QinTB’, for Smoking Cessation in Tuberculosis Patients: Study Protocol.” *BMJ Open* 9(12): 1–7.
- Maulidya, Yulinda Nur, Endang Sri Redjeki, and Erianto Fanani. 2017. “Faktor Yang Mempengaruhi Keberhasilan Pengobatan Tuberkulosis (Tb) Paru Pada Pasien Pasca Pengobatan Di Puskesmas Dinoyo Kota Malang.” *Preventia : The Indonesian Journal of Public Health* 2(1): 44.
- Na, Ling, and Jiunn Jye Sheu. 2022. “Health and Information Disparities among Non-Adopters of Smartphones.” *Health Policy and Technology* 11(1): 100600. <https://doi.org/10.1016/j.hlpt.2022.100600>.
- Napitupulu, Mastiur, and Lahmi Fitri Harahap. 2020. “Hubungan Peran Pengawas Menelan Obat (DTS) Dengan Keberhasilan Minum Obat Pasien Tuberkulosis Paru Di Wilayah Kerja Puskesmas Ulak Tano.” *Jurnal Komunitas Kesehatan Masyarakat* 2(1): 41–47.
- Shen, Yizhong et al. 2022. “Ratiometric Fluorescent Signals-Driven Smartphone-Based Portable Sensors for Onsite Visual Detection of Food Contaminants.” *Coordination Chemistry Reviews* 458: 214442. <https://doi.org/10.1016/j.ccr.2022.214442>.
- Tantawi, Omar, and Inez Hua. 2021. “Temporal Evolution of Metallic Element Composition and Environmental Impact in Consumer Electronic Devices: A Study of Smartphones.” *Resources, Conservation and Recycling* 175(February): 105886. <https://doi.org/10.1016/j.resconrec.2021.105886>.
- Tortajada-Genaro, Luis A., María Isabel Lucío, and Ángel Maquieira. 2022. “Fast DNA Biosensing Based on Isothermal Amplification, Unmodified Gold Nanoparticles, and Smartphone Detection.” *Food Control* 137(February).
- Wulandari, R, A Kusumawati, and PN Prabamurti. 2021. *Dukungan Sosial Keluarga Pada Pasien TB MDR Di Kota Semarang*. Media Kesehatan Masyarakat Indonesia.
- Wulandari, Rizkiana, Aditya Kusumawati, and Priyadi Nugraha Prabamurti. 2021. “Dukungan Sosial Keluarga Pada Pasien TB MDR Di Kota Semarang.” *MEDIA KESEHATAN MASYARAKAT INDONESIA*: 41–49.



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Social (IJHES)**

---

- Xu, Xiaoyan et al. 2021. "Smartphone-Enabled 3D Printing of Medicines." *International Journal of Pharmaceutics* 609(October): 121199. <https://doi.org/10.1016/j.ijpharm.2021.121199>.
- Yu, Long et al. 2022. "Portable Visual Assay of Bacillus Anthracis Biomarker Based on Ligand-Functionalized Dual-Emission Lanthanide Metal-Organic Frameworks and Smartphone-Integrated Mini-Device." *Journal of Hazardous Materials* 434(April): 128914. <https://doi.org/10.1016/j.jhazmat.2022.128914>.
- Yuda, Hendri Tamara, and Bambang Utoyo. 2018. "Peran Pengawas Menelan Obat (DTS) Terhadap Hasil Pengobatan Penderita Tuberculosis Paru Di Wilayah Puskesmas Gombang II 1Hendri." *Jurnal Ilmiah Kesehatan XI(II)*: 393–98.
- Zhang, Meiyang, Xin Cui, and Nan Li. 2022. "Smartphone-Based Mobile Biosensors for the Point-of-Care Testing of Human Metabolites." *Materials Today Bio* 14(April): 100254. <https://doi.org/10.1016/j.mtbio.2022.100254>.