A dynamic model of tuberculosis transmission and control in Zhejiang Province, China

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【Abstract】 Objective Build a mathematical model of the spread and control of tuberculosis to predict the number of tuberculosis cases and compare between different control strategies. **Methods** According to the tuberculosis transmission characteristics, drug-resistant epidemiological characteristics and clinical characteristics, design and calibrate a dynamic model. Predict the number of tuberculosis and multi-drug resistant tuberculosis cases from 2009 to 2050, compare the effect of different strategies in controlling tuberculosis. **Results** The number of tuberculosis and multidrug-resistant tuberculosis are projected to decrease slowly from 2009 to 2050. The long-term vision of national TB elimination cannot be achieved with current strategy. Increasing tuberculosis treatment success rate, treating latent tuberculosis, and reducing transmission rate could decrease tuberculosis incidence. **Conclusion** The established transmission and control model help to choose better tuberculosis control strategies in Zhejiang province and also helpful for the improvement of national tuberculosis control.

【Key words】 Tuberculosis; Multidrug-resistant tuberculosis; mathematical model; Predict; Prevention and control strategy

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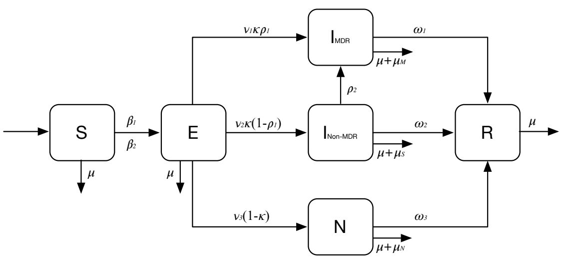
Below Presented the main of results of this study.

Figure 1. The flowchart of the TB model.



Model Equations:

$$\frac{dS}{dt}=\mu P+\mu_1 I_1+\mu_2 I_2+\mu_3 N-\beta_1 S I_1-\beta_2 S I_2-\mu S$$

$$\frac{dE}{dt}=\beta_1 S I_1+\beta_2 S I_2-(v_1+v_2+v_3+\mu)E$$

$$\frac{dI_1}{dt}=v_1\kappa\rho_1 E+\rho_2 I_2-(\omega_1+\mu+\mu_1)I_1$$

$$\frac{dI_2}{dt}=v_2\kappa(1-\rho_1)E-(\rho_2+\omega_2+\mu+\mu_2)I_2$$

$$\frac{dN}{dt}=v_3(1-\kappa)E-(\omega_3+\mu+\mu_3)N$$

$$\frac{dR}{dt}=\omega_1 I_1+\omega_2 I_2+\omega_3 N-\mu R$$

$$P=S+E+I_1+I_2+N+R$$

Figure 2. Projected trends of MDR-TB cases and total number of tuberculosis cases, Zhejiang, China, 2009-2050.

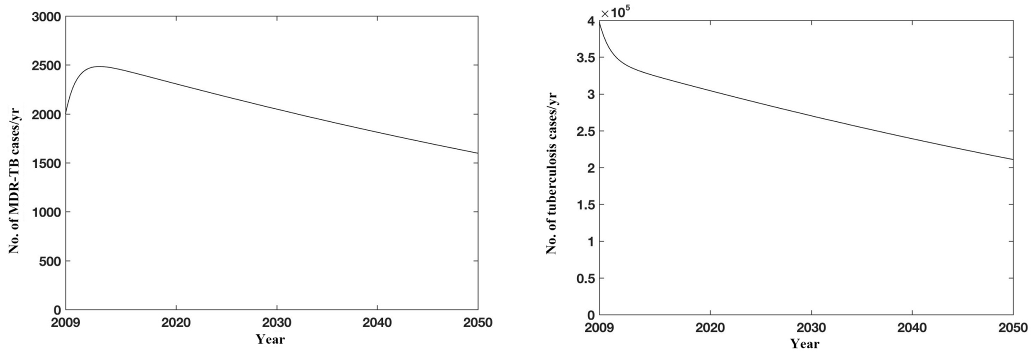


Table 1. The effect of possible interventions in reducing tuberculosis cases.

Interventions	Proportion (%)	Change in No. of cases (%)*	Interventions	Proportion (%)	Change in No. of cases (%)*
Improve treatment success rate	0	-	**Treat latent tuberculosis**	0	-
	5	8.02		5	3.56
	10	7.53		10	3.84
	15	2.40		15	4.14
	20	2.23		20	4.54
	25	2.05		25	4.86
	30	1.97		30	5.35
Decrease transmission rate	0	-	**Reduce drug resistance**	0	-
	5	3.75		5	0.19
	10	3.79		10	0.14
	15	3.79		15	0.19
	20	3.83		20	0.19
	25	3.93		25	0.14
	30	3.92		30	0.19

* Change in No. of cases (%)：projected to 2050.

Figure 4. Projected trends of the total number of tuberculosis cases under four possible interventions, Zhejiang, China, 2009-2050.